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Assessment of Incineration as a Treatment Method for Liquid Organic Hazardous Wastes Background Report 3. Assessment of the Commercial Hazardous Waste Incineration Market

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Assessment of Incineration As A Treatment Method for Liquid Organic Hazardous Wastes

Background Report III: Assessment of the Commercial Hazardous Waste Incineration Market

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This volume provides a two-part assessment of the market for incineration of liquid organic hazardous wastes. The first part is a profile of the current incineration market and the second part is an economic analysis which projects the demand for and supply of incineration capacity under alternative regulatory scenarios provided by the Agency.

The market profile focuses on market size, market shares, volumes incinerated, available technologies, and EPA's regulatory program for incineration. The economic analysis is an evaluation of incineration capacity utilization comparing estimated on-site and commercial capacity (i.e., supply) with estimated volumes to be incinerated (i.e., demand). This comparison is done for baseline market conditions, and a series of cases projecting demand and supply in response to several RCRA regulatory amendment scenarios. The study concludes that future demand for incineration capacity will significantly exceed current capacity as land disposal alternatives are restricted under new RCRA regulations.

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ASSESSMENT OF THE COMMERCIAL HAZARDOUS WASTE INCINERATION MARKET

March 1985

A background report for the study by EPA's Office of Policy, Planning and Evaluation: "Assessment of Incineration As A Treatment Method For Liquid Organic Hazardous Waste."

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Finally, the basic data used in this report have been reviewed for accuracy and completeness by the waste management industry, appropriate trade associations, and environmental groups. Their comments and suggestions were received in a one-day workshop held on November 8, 1984.

Identification of specific firms or technologies in this report does not constitute endorsement or approval by the U.S. Environmental Protection Agency. Questions concerning this report should be addressed to: John Chamberlin, Office of Policy Analysis (PM-220), U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460.

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EXECUTIVE SUMMARY

The U.S. EPA intends to develop an overall policy on the proper management of liquid organic hazardous wastes (LOHWs). The need for such a policy is driven, in part, by the reauthorization of the Resource Conservation and Recovery Act (RCRA) that calls for prohibitions or restrictions on certain management practices for these wastes. These regulatory changes would likely increase the demand for incineration capacity and other treatment capacity for these wastes.

The purpose of this study is to focus on current baseline supply and demand in the commercial incineration market, and to estimate how demand and supply may change in response to the proposed RCRA regulatory changes. This report presents the results of that incineration market assessment.

Baseline incineration capacity utilization estimates suggest that available on-site (i.e., captive) and commercial incineration capacity for LOHWs is not fully utilized. Both on-site and commercial capacity utilization may range anywhere from around 37 to about 74 percent for commercial capacity depending upon the estimated quantity of LOHWs currently incinerated. The lower estimate of 37 percent is based upon the EPA's analysis of waste-handling data from the 1981 National Survey applied to independent estimates of on-site and commercial incineration capacity. The higher estimate of 74 percent reflects industry suggestions that more LOHWs are currently incinerated than the EPA estimate. As a portion of the larger market, industry sources also report that commercial incineration capacity utilization for liquid PCBs is at or near 100 percent.

Both on-site and commercial incineration capacity utilization are expected to increase as a result of increased demand, even in the absence of the regulatory changes the EPA may implement. Over the short-term, the key factors behind an increase in the demand for commercial incineration are seen to include:

- An increased demand for PCB incineration capacity
- Generators' concerns over the long-term liabilities of impermanent waste disposal
- Increased Superfund clean-up activities
- Declining landfill capacity

- Slowed commercialization of alternative innovative technologies
- An absence of quickly available on-site incineration capacity.

Commercial incineration capacity is seen to grow little over the short-term as regulatory constraints (i.e., complexity of regulations, permit delays, siting difficulties) are perceived to result in a 3 to 5 year lag-time. Longer-term market forecasts for incineration demand and supply are less definitive.

With the regulations called for in the RCRA reauthorization legislation, the predictions are unanimous: without large increases in capacity, the demand for incineration will exceed supply. Commercial incineration firms characterize these changes as a "boon" to their markets. They claim that effects are already being felt as the market anticipates implementation of the expected RCRA rules.

The perceptions of industry are confirmed by the results of the scenario analyses as summarized in Exhibit S-1. Each of the land disposal restriction scenarios examined are projected to result in an excess of demand for incineration over existing commercial incineration capacity (fully utilized) by some 215 to 306 percent based on the average or mid-range sensitivity analysis.* The analysis of the waste-in-boilers restrictions indicated less of an excess in demand--only 106 percent of existing commercial incineration capacity (fully utilized).

Exhibit S-1 goes a step further to translate the estimated excess demand into incinerator equivalents. Two incinerator equivalent measures are shown -- the number of land-based facilities of probable future "average" capacity needed to accomodate the added demand, and the number of probable future "average" capacity incinerator ships that would accomodate the added demand. This approach translates the incremental change in demand for incineration into the most tangible form of a market response, the building of facilities and ships. As shown in the exhibit, as many as 26 land-based incinerator facilities (20,000 metric tons each) or 10 incinerator ships (50,000

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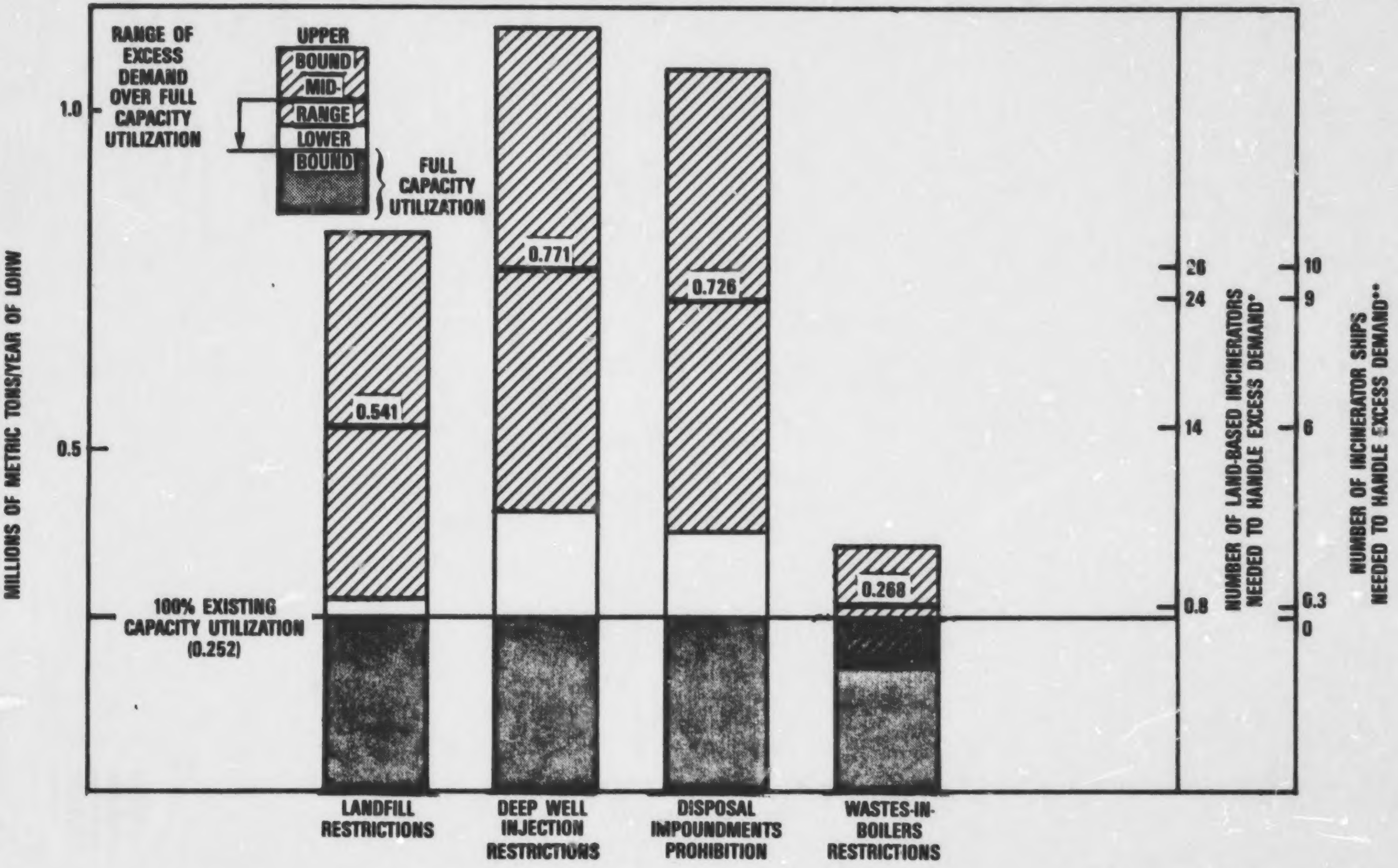
* Each scenario had at least one key assumption for which a range of possible values was offered by the sources consulted for the study. All the lower values of these ranges were used to construct a "low-range" case, and all the higher values were used to construct a "high-range" case. The mid-range case was the average of the lower and higher values.

EXHIBIT S-1

INCINERATOR EQUIVALENTS ESTIMATED TO BE NECESSARY TO HANDLE THE EXCESS DEMAND FOR COMMERCIAL INCINERATION CAPACITY FOR LOHWs UNDER 4 REGULATORY SCENARIOS



*PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR NEW FACILITIES = 20,000 METRIC TONS

**PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR SHIPS = 50,000 METRIC TONS.

metric tons each) would provide liquids incineration capacity equivalent to the excess of demand for incineration over existing commercial capacity predicted for the injection well restrictions scenario. Slightly fewer land-based facilities (24) or ships (9) would be equivalent to the excess demand estimated under the disposal impoundments prohibition scenario. The excess demand brought about by landfill restrictions is shown as equivalent to 14 land-based facilities or 6 ships. Not shown in the exhibit are future additions to existing capacity (land-based or at-sea) as no planned capacity data were available, or options such as combinations of land-based facilities and ships as a way to handle any estimated excess of demand under each of the regulatory scenarios.

I. INTRODUCTION

1. BACKGROUND AND OBJECTIVES

As part of an overall policy on managing liquid hazardous wastes, the U.S. EPA is conducting a comprehensive assessment of the benefits and risks of incineration as a means to treat/dispose of liquid organic hazardous wastes (LOHWs). Several interrelated areas of possible regulatory/policy change are focal points for this assessment:

- Amendments to prohibit or otherwise restrict land disposal of liquid hazardous wastes.
- Tighter controls over the burning of hazardous wastes in industrial boilers and furnaces
- The Agency's ongoing review of the need for and advisability of permitting incineration-at-sea of hazardous wastes (including development of the applicable regulations) as an alternative to land-based incineration
- Additions to the list of hazardous wastes and/or the lowering of the small quantity generator exemption under RCRA

These changes are likely to alter the economic forces that shape the current commercial, LOHW incineration market. Incineration-at-sea, if permitted by the EPA* and the states, would expand available capacity. Current commercial (and captive) LOHW incineration capacity could be taxed or exceeded over the short-term as large quantities of LOHWs move into the market in response to controls on burning hazardous wastes in boilers or from restrictions on land disposal. New waste listings and lowering the Federal small quantity generator exemption could also increase LOHW volumes available to be incinerated.

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* In May 1984, the EPA did not approve pending operating, research, and test burn permit applications for incineration-at-sea until completion of its overall LOHW incineration study and development of Federal regulations governing this practice.

The objective of this study is to provide the EPA with information on the current and probable future conditions of the commercial industry for incineration of LOHWs, including PCBs. Starting from a profile of the current market for commercial incineration of LOHWs, an economic analysis of commercial LOHW incineration capacity utilization is presented. This analysis serves two functions: to analyze market changes and project industry supply and demand in response to possible changes in the RCRA regulations, and to provide the EPA with an analytical tool for future evaluations of alternative scenarios as more and better data become available.

2. METHODOLOGY

This incineration market assessment is one component of a larger study being conducted by several EPA offices and contractors centered on a comparative risk analysis of land-based and incineration-at-sea of LOHWs. Several of these other studies are direct inputs to the market assessment. The market assessment itself consists of two parts--a profile of the current LOHW incineration market and an economic analysis of the industry to project the demand for and supply of incineration capacity under alternative regulatory scenarios provided by the Agency.

The market profile was developed from past EPA reports, extensive discussions with EPA staff, and contacts with leading firms in the hazardous waste management industry. The profile focuses on market size and participants' market share, LOHW volumes incinerated, available technologies, and the EPA's current* regulatory program for incineration. A particularly intensive area of investigation, led by the Office of Solid Waste, concerned estimating quantities of LOHWs managed by type and technology (see Appendices A and B). The principal source of these data was the National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981 (the 1981 RIA National Survey)(1,2).

The economic analysis portion of the market asessment is an evaluation of LOHW incineration capacity utilization comparing estimated on-site and commercial LOHW incineration capacity (i.e., supply) with estimated volumes of LOHWs to be incinerated (i.e., demand). This comparison is done for baseline market conditions, and a series of cases projecting demand and supply in response to several RCRA regulatory amendment scenarios (developed in consultation with the EPA). Projected trends in demand and supply are also examined in the absence of any significant regulatory changes.

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*Through September, 1984.

Baseline market conditions are established on the basis of three different estimates of commercial LOHW incineration capacity utilization. These varying estimates of baseline capacity utilization, reflect uncertainty over the present relationship of the demand for LOHW incineration and the supply of LOHW incineration capacity. Chapter III discusses these baseline estimates. In Chapter IV, the projected impacts of each regulatory amendment scenario are expressed as incremental increases above these baseline estimates.

Individual components or modules in the overall assessment were analyzed separately. For example, a module was devoted solely to estimating incineration capacity for PCBs. Modules were also developed for each regulatory amendment scenario. Each module was developed through the use of a logic diagram through which key data and assumptions could be displayed and tracked. Each analytical "template" visually traces the flow of logic behind the analysis leading to a final capacity utilization estimate. Its design allows for individual estimates and assumptions to be modified easily to generate new results. With these modules then, the EPA can perform iterative assessme[illegible] as new data become available or as policies are modified.

The logic diagrams presented in Appendix C trace the calculations for the most likely estimates for the data and assumptions in each module, drawn from the best available sources consulted during the study. In some of these cases, the most likely estimate is the approximate midpoint between a high and low bound for individual data/ assumptions as suggested by these sources. These high-range and low-range estimates within each module are summarized in Appendix D. Given that there is a range of possible estimates for some of the key data and assumptions, a sensitivity analysis has been incorporated into the economic analysis to capture the range of possible outcomes to each module calculation.

The sensitivity analysis has been built from the combination of lower and upper bounds for selected key data and assumptions across all the modules. For example, a "low-range estimates case" was developed out of the combination of the lowest estimates provided for these selected data and assumptions within each and every module. Similarly, a "high-range estimates case" was built from individual high-range modules that use the higher estimates suggested for these same key data and assumptions. Selecting an average between these two bounds is the "mid-range estimates case", presented here as the most likely case, if, for any one assumption, either the lower or higher bound may be correct. However, results of the low-range and high-range cases are presented along with the mid-range case analysis throughout the report.

3. LIMITATIONS

Use of a sensitivity analysis in this market assessment emphasizes that certain key limitations of this analysis should be kept in mind when evaluating its results. These limitations fall into two, non-exclusive classes, and each can be corrected for in the future as more and better data become available to the Agency.

(1) Limitations of a National-Level Analysis

The market assessment presented in this report has been conducted at the national level. Conceptually, one can conceive of a regional analysis and, in fact, such an analysis was contemplated originally. A regional analysis has several benefits, principal among these is the ability to assess regional costs and capacity shortfalls that might otherwise "wash out" at the national level. These regional impacts may be quite varied in response to the land disposal restrictions and other RCRA regulatory amendments.

The 1981 RIA National Survey data available on regional waste management capacities and quantities of LOHWs generated and managed by region, however, do not allow a regional focus for the market analysis. The absence of reliable LOHW quantity data for a regional analysis reflects the considerable statistical uncertainty in extrapolating to national level waste quantity data (acknowledged in the RIA National Survey report) from limited sample sizes when the data are cut by EPA region or by some form of service region. In its place, however, there has been an attempt to present some limited regional-based information. Commercial incineration facilities have been characterized as to their location in four service regions. Selected firms within these service regions have been contacted and asked for their general assessement of market activity, trends, and problems over the next five to ten years. These assessments are summarized in Chapter IV.*

(2) Data Inconsistencies and Unavailability

As noted earlier, data quality/uncertainty issues arise in several areas of the market assessment. Numerous sources of data were utilized in the analysis, and these sources often present inconsistencies that cannot be reconciled easily or at all. In some cases, estimates of the same parameter are conflicting or the relationships set by "good" estimates of two parameters run contrary to a third. Limitations in the RIA National Survey data are treated exhaustively in the Survey report. These range from limitations in the survey design to significant sampling and nonsampling errors. In addition, there are definitional differences between these sources and the use of similar terms in this report. Appendix E covers the definitions of key terms in this report.

Some of the necessary data also are not available in any easily accessible form. Several regulatory scenarios, for example, have yet to be developed fully pending further Agency study. In other cases, such as the demands Superfund clean-up activity may have on available RCRA capacity, sufficiently detailed data simply do not yet exist for conducting anything more than a very rough, preliminary analysis. In cases such as these, engineering judgment was applied to develop a range of possible estimates. This range of estimates was then used in the sensitivity analysis to calculate a range of capacity utilization consequences.

Whenever possible, attempts were made to reconcile and corroborate estimates and assumptions used in the analysis. This was not always possible. The primary concern, however, was to reach some consensus that these estimates/assumptions are at least reasonable or "in the ballpark", and to measure the sensitivity of the results to variations in these assumptions. All estimates and assumptions are documented as to their specific or general source given the confidentiality of some information collected during the study.

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* All industry respondents requested that their specific comments were to be considered confidential and, therefore, non-attributable.

4. ORGANIZATION OF THE REPORT

The remaining five chapters of the report follow the analytical progression from baseline market conditions to projected, regulatory-induced changes in incineration demand and supply. Chapter II presents a profile of the current incineration market. This profile includes an overview of the market's size and regional distribution, waste volumes and types handled, and the applicable regulations, and a discussion of market shares, prices, competition, and barriers to market entry.

This information is used in Chapter III to develop estimates of baseline LOHW incineration demand and supply. Both on-site and commercial baseline LOHW incineration capacity utilization is estimated. Also developed in this chapter are estimates of the volumes of hazardous wastes managed, on-site and off-site, in landfills, injection wells, disposal impoundments, and industrial boilers. These volumes represent those wastes that would be affected by the RCRA regulatory amendments discussed in Chapter IV.

Chapter IV looks at probable future demands on incineration capacity. Two forms of this projected demand are examined. In the first section, increases in demand are estimated in the absence of major regulatory changes. Conversations with industry sources indicate that this nonregulatory-induced increase in demand is likely, but difficult to quantify. Factors and influences behind this increase are identified. In the second section, several regulatory-induced changes in demand are analyzed. Each of the regulatory scenarios are analyzed separately. Their effect on demand is assumed to be instantaneous, that is, the analysis avoids speculating on a schedule of implementation for these regulations, and no additions to present capacity are assumed. Mid-range, low-range, and high-range demand estimates are presented. Included are scenarios on land disposal restrictions (landfills, injection wells, and disposal impoundments) and controls on burning hazardous wastes in boilers.

In Chapter V, probable increases in incineration capacity are estimated. This includes a discussion of industry's views of their ability to make additional capacity available over the next three to five years. In addition, data are presented on the development of incineration-at-sea capacity. It is expected that nearly all of this added capacity will be for thermal treatment of liquid wastes.

The analyses of projected increases in demand and supply come together in Chapter VI. The key feature of this comparison is the projected, regulatory-induced excess of demand over full-capacity supply as translated into land-based and incineration-at-sea equivalents. Any excess of the demand for incineration over full-capacity levels (mid-range estimates of demand only) is equated to an estimated number of land-based incinerators of "average" capacity and an estimated number of "average" capacity incinerator ships. This provides a consistent basis for measuring and comparing the supply and demand impacts of the various regulatory amendments to RCRA on the commercial incineration market. Though not equated to incinerator equivalents, results of the lowand high-range demand analyses are presented.

II. INCINERATION MARKET PROFILE

Understanding the potential impact of anticipated regulatory amendments requires definition of a starting point or baseline to which comparisons can be made. In this section, a profile of the current commercial incineration market is presented as background for baseline estimates of incineration capacity utilization. General information is presented on market size and participants, waste volumes handled, available technologies and capacity, and on the existing regulatory approach for incineration. The economic structure of the market is described including estimates of market shares and prices. Also discussed are competitive pressures, barriers to entry, and growth strategies. Some information is also developed on the regional character of the commercial incineration industry.

1. MARKET SIZE AND REGIONAL DISTRIBUTION

Estimates of the number of commercial incineration facilities range from 25 to 40 (3,4,5,6,7). These are privately owned/operated facilities that have (or intend to have) incineration capacity devoted mostly to handling wastes, for a fee, from other firms.* Far more firms can provide access to incineration capacity, but only through other firms that they do not own. Estimates of on-site or captive incineration facilities range from 200 to 210 firms (3).

The range in the estimated number of commercial facilities reflects growth in the market over time, errors in the available data, and differences in defining commercial activity. For example, sources of these estimates cover a period from December 1980 to July 1984, during which incinerator units have come on-line or gone out-of-service. Permit status also changes with time. Commercial facilities, whose Part A permit data indicates incineration activity, may later be denied a permit to operate, or they may discontinue plans to operate a hazardous waste incinerator.

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* This is the preferred definition of "commercial" for the market study. This definition focuses on wastes originating from off-site and from other firms. This definition is intended to include intrafirm shipments between off-site commercial facilities, but exclude intrafirm shipments between a generator and a captive TSD owned by the generator (see also Appendix E).

The estimated total number of operating hazardous waste incinerators ranges from 270 to 340 units depending upon completion of planned construction (3). Commercial facilities may account for 30 to 50 of these units, that is, some 80 percent of hazardous waste incinerators operate at the generator's site or as part of a captive hazardous waste management facility (3).

Many of the incineration facilities, both on-site and commercial, and most of the incinerator units, are located in the Southeast and Southwest as shown in Exhibit 1. Fewer firms are located in the Middle Atlantic and North Central regions of the U.S., but commercial firms in these areas have significant capacity. Even fewer firms are located in the Western U.S.

2. INCINERATION TECHNOLOGY AND CAPACITY

For handling LOHWs, liquid injection is the primary incineration technology. Other technologies, such as rotary and cement kilns, can also handle liquids as well as solids. The Mitre Telephone Survey (3) indicated that 52 percent of all reporting hazardous waste incinerators were liquid injection units.* In total, some 77 percent of all the incinerators reporting could handle liquids, including liquids-capable multiple hearth/chamber units, rotary kilns, and fume incinerators. Exhibit 2 shows the distribution of operational hazardous waste incinerators by technology as estimated by Mitre (3). Additional data obtained by Mitre indicate that while liquid injection units dominate, newer units tend to be rotary kilns or fume incinerators. This general trend is confirmed by industry sources.

Total incineration capacity for all hazardous wastes (or just LOHWs) is difficult to estimate. Exact capacity of individual units is generally not known or the available data reflect respondents' different interpretations of capacity (e.g., hourly throughput capacity, heat capacity, annual total capacity). Operational parameters--hours

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* Data on incinerator units by type are also available from the RIA National Survey. However, as of this writing, efforts are still underway to verify and correct these data.

EXHIBIT 1
Commercial and Non-Commercial Incineration Facilities By Region

EPA REGION	NON-COMMERCIAL INCINERATION FACILITIES (SOURCE: (3))	COMMERCIAL INCINERATION FACILITIES (SOURCE: (3))	COMMERCIAL INCINERATION FACILITIES (SOURCE: (4))	COMMERCIAL INCINERATION FACILITIES (SOURCE: (7))	COMMERCIAL INCINERATION FACILITIES (SOURCE: (6))
I	7	1	5	3	3
II	26	2	6	1	2
III	26	3	4	1	4
IV	38	9	11	7	13
V	28	4	6	6	7
VI	57	6	6	6	3
VII	22	1	1	0	2
VIII		0	0	0	0
IX		2	1	1	1
X		0	0	0	0
	204	28	41	25	38

EXHIBIT 2
Distribution of Operational Hazardous Waste Incinerators by Type

INCINERATOR TECHNOLOGY	NUMBER REPORTED BY MITRE	PERCENT OF TOTAL
Liquid Injection	137	51.9
Hearth/Chamber	56	21.2
Liquids	33	
Solids	23	
Rotary Kiln	11	4.2
Liquids	10	
Solids	1	
Fume (Liquids)	24	9.1
Controlled Air	-	
Combination	5	1.9
Miscellaneous (Solids)[a]	31	11.7
	264	100

a) Includes ammunition/explosives units, drum burners, and other solid units.

SOURCE: (3).

per day, days per year, and so forth--are also so variable as to be difficult to characterize as "typical". The data that are available on liquids incinerator unit capacities, however, are shown in Exhibit 3(3).* A wide range of throughput capacity is indicated, but the distribution is skewed towards generally smaller (less than 200 gallons/hour) units. Using these data, an estimate of total available baseline LOHW capacity, on-site and commercial, is developed in Chapter III.

3. WASTE VOLUMES AND TYPES HANDLED

Those waste types that are liquids and incinerated or potentially incinerable are the target wastes for this market analysis. Information on the types of waste streams incinerated comes from the 1981 RIA National Survey (2). The Office of Solid Waste (OSW) has coordinated the development of this information.

Exhibit 4 summarizes the waste type and volume data obtained from RIA National Survey. Estimates of the volume of LOHWs incinerated in 1981 range around 0.9 million metric tons (MMT).** Most of this amount is accounted for by three waste code categories: miscellaneous commercial chemical product wastes, ignitable wastes, and solvents. According to survey data, 98 percent of these wastes were incinerated on-site.

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* Data in the RIA National Survey can be used to develop capacity estimates by technology. As of this writing, however, OSW's efforts to develop such an estimate for commercial incineration capacity had not been completed. The main difficulties were proper interpretation of design hourly feed rates (expressed in mass units) provided by respondents to the survey, and scaling up from a limited survey sample of commercial facilities to national totals. These problems forced the use of independent estimates of total and commercial incineration capacity.

** The RIA National Survey itself consisted of several general and technology-specific questionnaires. Sources for LOHW quantity data are adjusted responses to the TSD General Questionnaire and data from the Incinerator Questionnaire. OSW prefers to use responses from the Incinerator Questionnaire (1).

EXHIBIT 3
Capacity of Operational Liquid Hazardous Waste Incinerators

CAPACITY RANGE (gal/hr)	Number of Units	Percent of Total
0 - 50	49	26.5
51 - 100	29	15.7
101 - 200	24	13.0
201 - 300	23	12.4
301 - 500	11	5.9
501 - 1,000	22	11.9
1,001 - 2,000	17	9.2
2,001 - 5,000	6	3.2
5,001 - 10,000	4	2.2
Total Reporting	185	100.0
Unknown Capacity[a]	24	
Total	209	

SOURCE: (3)

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[a] These non-reporting units were operated by commercial incineration firms.

EXHIBIT 4
Liquid Organic Hazardous Wastes Incinerated In 1981 By EPA Waste Code or RIA National Survey Waste Combination Code[a]

EPA Waste Code or RIA National Survey Combination Code	Amount Incinerated As Liquid (Metric Tons/Yr)[b]
D000	19,159.2
D001	227,463.5
D002	10,637.8
D003	12,973.7
F001	33.5
F002	6,003.3
F003	90,112.8
F005	65,705.3
K001	66.9
K015	569.1
K016	3,656.3
K018	5,735.5
K036	301.3
K083	1,963.9
K085	1,472.9
K093	662.1
P063	230.6
P068	148.8
PO74	874.1
P106	3.7
U002	1,926.7
U003	9,068.2
U023	941.0
U031	357.1
U043	2,440.0
U044	3.7
U053	93.0
U056	401.7
U074	2,745.0
U080	7.4
U098	7.4
U117	7.4
U122	915.0
U123	3.7
U133	89.3
U154	297.6
U188	4,307.2
U196	3.7
U220	3.7
U223	178.5

EXHIBIT 4 (Continued)
Liquid Organic Hazardous Wastes Incinerated In 1981 By EPA Waste Code or RIA National Survey Waste Combination Code[a]

EPA Waste Code or RIA National Survey Combination Code	Amount Incinerated As Liquid (Metric Tons/Yr)[b]
X001	22.3
X002	535.6
X013	2,436.3
X015	5,545.8
X028	1,335.3
X042	23,232.1
X072	2,640.9
X110	2,387.9
X124	3.7
X175	1,606.8
X179	11.2
X182	300,775.3
No Code	46,326.6
	858,431.7
	(0.86 million metric tons/year)

a) See also Appendices A and B.
b) Assumes 268.8519 gallons per metric ton.

SOURCE: (1).

Appendix A lists those EPA waste codes or RIA National Survey waste combination codes OSW defines as potentially incinerable LOHWs (1). This list was developed from responses to the RIA National Survey that indicated the physical form and volumes of incinerated wastes, combined with incinerability rankings drawn from the Engineering Handbook for Hazardous Waste Incineration (8). Appendix B describes the series of analyses behind the estimated volumes of LOHWs incinerated, and the on-site versus off-site splits of these totals.

Efforts continue at the EPA to refine incineration-related information from the survey. These additonal studies will attempt to more carefully characterize incinerated waste streams (particularly the characteristic wastes) by waste code and physical form to eliminate double counting of certain waste streams.*

4. REGULATORY APPROACH FOR INCINERATION

The regulatory programs governing land-based and sea-based incineration are derived from three statutes. Land-based incineration of all non-PCB hazardous wastes is covered under the RCRA regulations. The incineration of PCBs is a special regulatory area under the authority of the Toxic Substaces Control Act (TSCA). Regulation of incineration-at-sea is, as yet, not fully developed as a regulatory program. Statutory authority for these regulations is derived from the amended Marine Protection, Research, and Sanctuaries Act.

A review of these statutes and programs has been developed by the EPA as part of the larger incineration study (9). Exhibit 5 highlights their analysis. In summary, these programs share several similarities in their approach, but differences do exist in at least four areas: technical requirements, permitting procedures, issues of potential liability, and in a "needs" determination process required for permitting incineration-at-sea.

5. MARKET SHARES AND COMPETITION

While there are anywhere from 25 to 40 commercial incineration facilities, only 5 to 10 of these facilities are generally viewed as "majors", especially on a national

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* For example, a respondent might report an incinerated F003 wastestream twice as a D001 and F003 wastestream. The EPA's reclassification might list this wastestream as a F003 waste only.

EXHIBIT 5
Similarities/Differences in Technical Requirements For Incineration Among Regulatory Programs

Technical Requirement	Incineration-At-Sea (MPRSA) (As Proposed Regulations)	Land-Based Incineration (RCRA)	PCBs (TSCA)
Hydrogen chloride	Total acid forming emissions after dispersal and initial mixing shall lead to less than a 10 percent change in alkalinity	99.9% removal or no more than 4 lbs. an hour	Limited as specified by Regional Administrator
Particulates	No limit	Less than 0.08 grains/dscf corrected for amount of oxygen in stack gas	
Destruction efficiency (DE) or destruction removal efficiency (DRE)	DE: 99.99% (99.9999% for PCBs)	DRE: 99.99%	Liquids: 99.9% combustion efficiency Solids: 99.9999% DRE
Residence time; temperature	1 second or longer;1100°C	Determined by trial burn	2 seconds at 1200°C 1.5 seconds at 1600°C
Environmental monitoring	Extensive	Not required	Not required
Stack monitoring	Proposed for 10 parameters including potential products of incomplete combustion	Required for 5 parameters	Required for 6 parameters
Waste analysis	Required before each burn - extensive	Specific plan developed for permit - must be followed	PCB content limited per trial burn

SOURCE: (9) with additional changes derived from conversations with EPA staff.

level. These facilities (and a few others) also control significant regional market shares.

Definitions of a market share in this market do vary. The major facilities can be chosen on the basis of estimated total existing capacity to incinerate all hazardous wastes and estimated revenues. How much of this existing capacity is being utilized, however, may not be known. Some of these facilities may be operating at or near capacity. Percent capacity utilization, therefore, may be an important market-share estimate criterion.

Capacity and capacity utilization also vary by waste type. For example, industry sources indicate that existing incineration capacity for PCBs is fully utilized (10). This reflects both the mandatory and voluntary phaseout of electrical equipment containing PCBs, and operating problems experienced by the permitted incineration facilities that limit their total available capacity. Market shares, therefore, can also be ranked by available capacity for individual waste types. Facilityand waste-specific capacity utilization data, however, are generally not available.

The commercial incineration market is being viewed as increasingly competitive by industry sources. This increased competitiveness is seen as taking two forms: cost competitiveness of thermal treatment with land disposal, and competition among commercial firms to capture larger market shares.

Thermal treatment of liquid wastes is becoming more cost competitive with waste management technologies, such as landfills, which have historically enjoyed a cost advantage. Changes to the RCRA program in recent years, and those expected to be promulgated, are seen as important influences to the narrowing of this historical, up-front cost differential. The Superfund program has also brought about a narrowing of the full cost differential between landfills and incineration, that is, costs including consideration of potential long-term liabilities. Incineration industry sources characterize the Superfund program's influence as leading their customers to "prefer" incineration of their wastes (liquid, solid, and sludge) as a less risky alternative in terms of potential long-term liabilities. This expected preference translates into industry's projections of a broadened and bullish market for commercial incineration services, especially in light of assumptions that, on the margin, many generators will presently choose not to expend the resources necessary to have a fully permitted treatment/disposal facility. Industry sources do acknowledge, however, that the "lessons" of the Superfund program may induce some of the larger generators to expend these the resources in the interest of maintaining full control over the disposition of their wastes, and may result in the additon or expansion of on-site incineration capabilities.

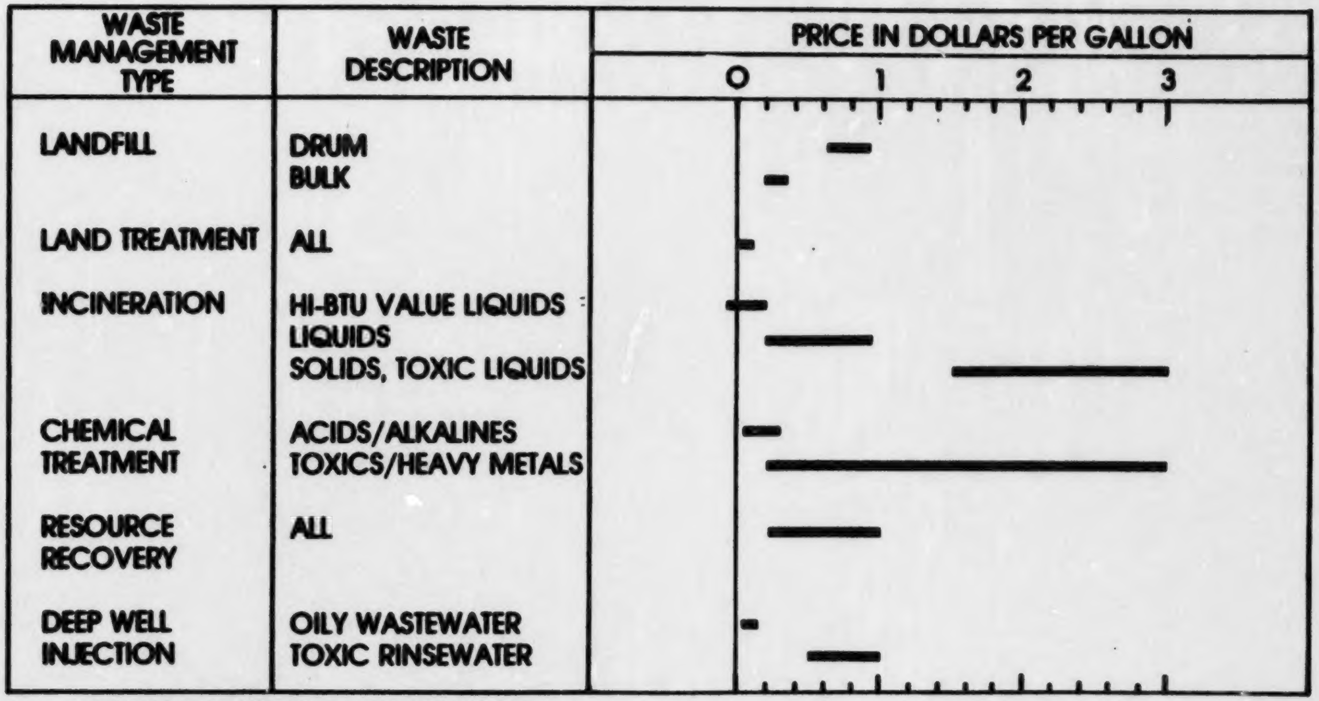
Expectations for a growing commercial incineration market also present the prospect of increased competition among existing facilities. Contacts with commercial incineration firms indicate that a lead time of three to five years must be anticipated when seeking to add or expand permitted incineration capacity (11). Such lead times, in fact, are being built into their plans to bring new facilities or units on-line. Over the short term, this leaves existing firms larger and medium sized firms in particular with finite capacity competing with each other to capture their share of a growing market.

6. PRICES

Many of the competitive influences discussed above would tend to dictate high per unit prices for incinerated hazardous wastes. Some waste types do, in fact, command a premium. Exhibit 6 shows, however, that per unit incineration prices actually vary over a wide range. Engineering difficulties in handling the waste and its emission products once burned, and the degree-of-hazard involved, largely determine the extent of this price range (excluding transportation costs). Other major price determinants include the revenues received from energy recovery (if practiced) and the cost to obtain higher Btu-valued wastes to burn with lower Btu-valued wastes. This latter "cost" has become a more significant factor as generators retain high Btu-valued wastes to reuse or to incinerate (and recover energy from) on-site.

In the LOHW incineration market, available capacity for a particular waste type can influence prices. For example, given the high demand for and limited supply of PCB incineration capacity, facilities permitted and not permitted to burn the higher priced PCBs are able to charge near PCB prices for all other incinerable hazardous wastes. Generators must pay this higher price either to induce an incineration firm to handle a non-PCB waste instead of PCBs, or because a non-PCB permitted facility can command a higher price in the face of an increase in the demand for their services. Some of the major facilities with the greatest available capacity are almost entirely dedicated to handling PCBs, leaving generators of non-PCB wastes to seek out medium-sized and smaller facilities with less capacity. Industry sources also report that the

EXHIBIT 6
Comparison of Quoted Prices for Nine Major Hazardous Waste Firms in 1981 By Waste Technology



TRANSPORTATION–$0.15/TON-MILE

Source: (12)

PCB market activity is so brisk as to create two to three month-long backlogs of both PCBs and non-PCB wastes waiting to be incinerated at several facilities (given current practical operational maximums)(11).

7. BARRIERS TO MARKET ENTRY

The ability of incinerator firms to enter the market or to add/expand available capacity is a critical issue for the market analysis. Incineration firms contacted indicated that public opposition to and regulatory requirements for permitting hazardous waste incinerators may mean a three to five year delay before a new unit is online and operational. These problems are cited as major impediments to market entry or expansion.

Incineration technology and services also require a substantial capital investment. Locations must be chosen and markets selected that afford a reasonably certain supply of incinerable wastes sufficient to offset that investment. This creates a business risk that is considered carefully by companies planning to enter the market or to expand their market position. Large business risks may also figure in any delay in market response to a "ghost" regulatory market until these regulatory changes become more defined.

8. FINANCIAL POSITION AND MARKET STRATEGIES

Financial data are only available for some of the larger, multi-service, waste management companies, and these data frequently fail to separate out their incineration operations. Industry sources indicate that incineration services may account for 15-25 percent of total off-site waste management revenues (11). This share is likely to increase.

A major market strategy of the last three years in the commercial waste management industry has been the expansion of capabilities and/or capacity by acquisitions. While this has been an industry-wide trend, it has been less visible in the commercial incineration market. There have been some notable exceptions, among them SCA Chemical Services' acquisition of an incinerator in Chicago, Illinois, and, now, Waste Management Inc.'s successful acquisition of SCA. These acquisitions do not result in any net change in industry-wide capacity, but they can introduce new participants to the market, and lead to higher market prices.

III. BASELINE INCINERATION SUPPLY AND DEMAND

Baseline capacity utilization estimates suggest that available on-site and commercial incineration capacity for LOHWs is not fully utilized. Both on-site and commercial LOHW incineration capacity utilization may range anywhere from 40 to 80 percent depending upon the quantity of LOHWs presently incinerated. The lower estimate is based upon the EPA's analysis of waste handling data from the 1981 RIA National Survey applied to independent estimates of on-site and commercial LOHW incineration capacity.* The higher estimate reflects industry suggestions that the quantity of LOHWs incinerated is higher than EPA's estimate, and that commercial capacity utilization is around 80 percent. As a portion of the larger market, industry sources also report that currently permitted commercial incineration capacity for liquid PCBs is fully utilized.

In this section, market profile information in Chapter II is used to develop baselines for the regulatory scenario analyses. Baseline estimates are developed for:

- Incineration of LOHWs: Current On-Site and Commercial Capacity Utilization
- Incineration of PCBs: Quantities Incinerated and Available Capacity
- Incineration Demand: Influence of Superfund Clean-Up Activities
- Incineration Demand: Quantities of Wastes Managed in Landfills, Injection Wells, Boilers and Disposal Impoundments.

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* As of this writing, EPA staff were still involved in an effort to use the RIA National Survey data base to develop estimates of commercial and noncommercial LOHW incineration capacity. Difficulties encountered in this effort have included: determination of practical maximum operating hours per year; interpretation of design feed rate capacities as expressed in mass units; and attempting to scale up a small survey sample of commercial firms to national totals. Given that this analysis is incomplete, the market study relies on industry's estimates of commercial LOHW incineration capacity as determined through a series of phone interviews with commercial industry respresentatives.

Detailed descriptions of the data and assumptions behind these baseline estimates are covered in Appendices A and B. Highlighted in the following sections are the results of these baseline analyses, and a description of a sensitivity analysis based on variations in the key assumptions.

The range of possible outcomes in this baseline analysis and the scenarios analysis in Chapter IV must be emphasized. Some data for the analyses are either not available and must be estimated, or different sources lead to estimates that differ and cannot be resolved. Where the data have had to be estimated, the reasonableness of these assumptions has been confirmed, whenever possible, in discussions with EPA staff and industry sources. Where sources differ in their estimates, a range of possible estimates have been incorporated into a sensitivity analysis. In Appendix C, portions of the analysis where key assumptions have been modified in the sensitivity analysis are indicated in the logic diagrams (within the dotted-line boxes). Appendix D presents additional data on the sensitivity analysis itself.

1. INCINERATION OF LOHWs: CURRENT ON-SITE AND COMMERCIAL CAPACITY UTILIZATION

Baseline commercial LOHW incineration capacity utilization, based upon RIA National Survey estimates of the quantity of LOHWs incinerated, is estimated to be 37 percent. Discussions with commercial incineration firms suggest that LOHW incineration capacity utilization (including for PCBs) is closer to 80 percent with liquid PCB incineration capacity utilization (as a portion of the total LOHW market) at near 100 percent. Impressions of noncommercial LOHW incineration capacity utilization are not as firm, but generally range from 20 to 60 percent.

As shown in Exhibit 7, estimates of commercial incineration capacity utilization for LOHWs range from 37 to 74 percent. Noncommercial or on-site LOHW incineration capacity utilization is shown to range from 27 to 54 percent. The estimates of the lower end of these ranges are based upon:

- An estimated 0.8 MMT of LOHWs incinerated on-site against 3.1 MMT of available on-site LOHW incinerator capacity

EXHIBIT 7
Estimated Baseline LOHW Incineration Capacity Utilization--Mid-Range Case[a]

ESTIMATED DEMAND

TOTAL QUANTITY OF LOHWs INCINCERATED	ONSITE/OFFSITE SPLITS	TOTAL QUANTITY INCINERATED ONSITE	TOTAL QUANTITY INCINERATED OFFSITE
1.392 million metric tons/yr	90% onsite 10% offsite	1.253 million metric tons/yr	0.139 million metric tons/yr

ESTIMATED CAPACITY

TOTAL LOHW INCINERATION CAPACITY	ONSITE/OFFSITE SPLITS	TOTAL ONSITE LOHW INCINERATION CAPACITY	NET TOTAL OFFSITE LOWH INCINERATION CAPACITY
3.4 million metric tons/yr	91.2% onsite 8.8% offsite	3.1 million metric tons/yr	0.30 - 0.048[b] = 0.252 million metric tons/yr

CAPACITY UTILIZATION

Onsite	Offsite
40%	55%

a) See also Appendix C

b) Amount of capacity estimated to be devoted solely to incineration of liquid PCBs

- An estimated 0.09 MMT of LOHWs incinerated at commercial facilities against 0.252 MMT of available "net" commercial LOHW incineration capacity (where net capacity equals total commercial LOHW capacity (0.3 MMT) minus PCB incineration capacity (0.048 MMT)).

These estimates of the quantity of LOHWs incinerated presently on-site and off-site are derived from the RIA National Survey estimate of 0.9 MMT of LOHWs incinerated in 1981 and the assumption that 90 percent of LOHWs are incinerated on-site. Alternatively, industry source's suggestion that commercial LOHW incineration capacity utilization is closer to 80 percent would indicate that the quantity of LOHWs incinerated may be as high as 1.86 MMT against a "net" available capacity of 0.252 MMT. This is shown in Exhibit 7 as the high range estimate of 74 percent commercial capacity utilization. Given these bounds, therefore, a most likely estimate of commercial capacity utilization for LOHWs may be about 55 percent (i.e., quantity of LOHWs incinerated = 1.4 MMT).

There are varying degrees of confidence in the reasonableness of these estimates. On the demand side, the RIA National Survey estimate of 0.9 MMT of LOHW's incinerated is subject to two sources of uncertainty. First, there is some question as to whether the list of LOHWs developed by the EPA (see Appendix A) may lead to overestimating or underestimating the total quantity of LOHWs incinerated. Second, there are numerous uncertainties in the survey data itself, that is, the confidence bands associated with the waste quantity data are quite large. Finally, the base year for the Survey is 1981; current quantities of LOHWs incinerated are likely to be higher. Discussions with industry sources indicate that their estimate of near 80 percent capacity utilization reflects such a higher estimate of demand.

There seems to be, however, some reasonable agreement between industry sources and the RIA National Survey data as to the 90 percent on-site and 10 percent off-site split of the total LOHWs incinerated. Analyses of the data on total LOHW quantities provided by OSW indicate a 93 percent on-site versus 7 percent off-site split (see Appendix B). Industry sources confirmed a 90 percent on-site and 10 percent off-site distribution as reasonable.*

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* It should be pointed out that current knowledge of on-site or noncommercial incineration activity is based more on speculation or extrapolation of limited data rather than on extensive quantitative information.

The reasonableness of total existing on-site and commercial LOHW incineration capacity estimates is hard to judge. The 3.4 MMT of total LOHW incineration capacity represents a modified estimate from Mitre's study (3), drawing upon practical maximum operational characteristics for commercial incinerators. Mitre's data on incinerator hourly throughput indicated a median value of 595 gallons per hour from a census/survey of 209 incineration facilities. Conversations with commercial incinerator operators indicated that as a practical maximum, their units run 24 hours per day for 300 days per year (i.e., 7200 hours per year or 82 percent of all the hours in one year).*

The 91 percent on-site and 9 percent off-site distribution of this total 3.4 MMT of incineration capacity for LOHWs is an assumption derived from fixing current commercial incineration capacity for LOHWs (including for liquid PCBs) at 0.3 MMT. This commercial incineration capacity figure is a rounded estimate of capacity totals suggested by some industry sources following their three-tier view of capacity as shown in Exhibit 8. In total, industry sources place available commercial incineration capacity for LOHWs between 0.250 and 0.285 MMT.

It should be noted, however, that given the preference of expressing incineration capacity as a heat release capacity, these capacity estimates expressed in mass units should be interpreted cautiously. Industry sources asked to estimate commercial incineration capacity for LOHWs had to make a variety of judgments based on their individual experience and expertise. For example, conversion of an incinerator's heat release capacity rating into a mass throughput requires knowing the heating values of the waste streams burned (and other characteristics that affect

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* Industry sources report that 80 to 85 percent of the hours in a year can be considered as a practical maximum under conditions of sufficient demand and assuming otherwise maximum operational performance. This translates into an estimated downtime period for repairs and replacement of 30 days per year plus a buffer of at least 3 days per month to account for electrical outages, re-start time, sub-optimal performance conditions, bad weather, and the like. Practical maximums of 90 to 95 percent of the hours in any one to two month period may be possible when burning easily handled, "clean" liquids.

EXHIBIT 8

Commercial Incineration Capacity For Liquid Organic Hazardous Wastes

Commercial Incineration Firms By Size Class	Average Annual Capacity For Hazardous Wastes (Metric Tons/Yr)	Average Annual Capacity For Liquid Organic Hazardous Wastes (Metric Tons/Yr)
First Tier Firms		
Largest 3 Firms (5 Incinerator Units)	0.159[a]	0.111[b]
Second Tier Firms		
2 Mid-Size Firms (2 Incinerator Units)	0.032-0.036[c]	0.032-0.036[d]
Third Tier Firms		
About 25 Smaller Firms (25 Incinerator Units)	0.113[e]	0.113[d]
Total All Firms	0.304-0.308	0.256-0.260

a) Assumes a capacity of 70 million lbs. per year per unit.
b) Assumes 30 percent of total capacity for solids, 70 percent for liquids per unit.
c) Assumes a capacity of 35-40 million lbs. per year per unit.
d) Assumes all of total capacity is for liquids.
e) Assumes an average capacity of 10 million lbs. per year per unit.

the combustibility of the waste or handling of the combusion products). A rotary kiln rated at 120 million Btu per hour can burn 15,000 lbs per hour of a 8000 Btu per pound waste opposed to only 10,000 lbs per hour of a 12,000 Btu per pound waste. If supplemental fuel is required to support combustion of a low Btu-value waste, however, less throughput of the waste (in mass terms) can be achieved. When asked to estimate commercial incineration capacity in metric tons per year, therefore, industry sources were told to assume an average waste given the types of wastes they handle.

Industry sources questioned also had to consider the physical form (i.e., liquid, solid, or sludge) of the waste streams burned at their facilities, especially those facilities with rotary kiln units. Rotary kilns can burn a combination of liquid, solid, or sludge-type wastes. This means that their capacity for liquids is not exclusive of their capacity for other waste types, that is, if fewer solids are burned, there is more capacity available to burn liquids. Industry sources were told, therefore, to assume their current waste feed mix in calculating their current capacity to burn LOHWs. Chapter V examines how changes in the waste feed mix (reflecting changes in demand) could change the estimate of availabale commercial incineration capacity for LOHWs.

2. INCINERATION OF PCBS: QUANTITIES INCINERATED AND AVAILABLE CAPACITY

As a special regulatory topic and area of commercial incineration industry activity, the incineration of PCBs was examined as a separate market analysis module. Estimates of liquid PCB quantities incinerated and available capacity were developed. Data sources included the July, 1982, PCB Use Rule RIA (13), permit information supplied by the EPA, the February, 1982, EEI/USWAG report on PCBs (14), and discussions with industry contacts (11).

Permit information provided by the Office of Pesticides and Toxic Substances in May, 1984, indicated that the four commercial incinerators permitted to burn PCBs* have a combined annual capacity of 57,415 metric tons (0.057 MMT) of PCBs. This was confirmed by industry sources (11).* For this market analysis, 3,673 metric tons of likely captive capacity (the General Electric facility) was not counted leaving a net available annual capacity of 53,742 metric tons. Ninety percent of this figure, or 48,368 metric tons, was assumed to be liquid PCB incineration capacity.

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* These incinerators are owned and operated by ENSCO in Arkansas, Rollins Environmental Services in Texas, SCA Chemical Services in Illinois (now owned by Waste Management, Inc.), and General Electric in Massachusetts.

Industry sources indicate that commercial PCB incinerators are operating currently at or near full capacity for PCBs.** This assumption of 100 percent capacity utilization was incorporated into the PCB incineration analysis, that is, the baseline total volume of liquid PCBs incinerated was set at a figure equal to the estimated liquid PCBs capacity, or 48,368 metric tons.

At an assumed 184 gallons/metric ton, this 48 thousand metric tons of capacity equates to a total of 8.9 million gallons of liquid PCBs. It is assumed, therefore, that the volumes of liquid PCBs originating from the phaseout of PCB capacitors and askarel transformers, the failure of PCB-contaminated mineral oil transformers, and past storage (so-called carryover volumes) of liquid PCBs should equal a total of 8.9 million gallons. Discussions with PCB incineration firms indicate, however, that demand for liquid PCB incineration capacity actually exceeds current capacity for PCBs as reflected in two to three month backlogs for handling these wastes. No data could be assembled, however to quantify this reported excess of demand.

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* Questions of how to define incineration capacity for PCBs were raised by industry sources contacted. Some felt that the capacity estimates expressed as a mass throughput should include not only the PCBs, but the PCB-contaminated fluids or products as well. Given their estimate that for every pound of PCB-contaminated fluid burned that 15 to 20 percent are PCBs, the capacity estimates shown in Appendix C would be five to six times greater than shown. The estimates used, however, reflect only the PCBs and these estimates appear reasonable given the 15 to 20 percent rule-of-thumb. Wastes burned with the PCBs are considered not part of the capacity for PCBs.

** As used here, full capacity refers to a maximum capacity industry defines on the basis of current operational performance that, in some cases, is not optimal, and on the basis of permit limits that are subject to change. This does not mean that these incinerators are operating at 100 percent of their rated capacity for all wastes.

The complete PCB module is presented in Appendix C. The module estimates both the quantities of PCBs incinerated (i.e., demand) and available commercial incineration capacity for PCBs (i.e., supply). The demand analysis is presented in keeping with the demand versus supply symmetry of the other modules, however, it is not a critical analysis for the remainder of the market assessment. In fact, as noted below and in Appendix C, there are considerable uncertainties to the demand analysis.

The supply or capacity analysis, however, is important to the overall market assessment. The estimate of commercial incineration capacity for liquid PCBs derived from this module is subtracted from the total commercial incineration capacity figure to generate a net capacity figure for all other LOHWs. This net capacity figure includes, therefore, capacity used to burn everything else, except the PCBs themselves, including the fluids contaminated by the PCBs.

The key data and assumptions from the PCB module analysis are summarized in Exhibit 9. Data in the PCB Use Rule RIA and the EEI/USWAG reports provided:

- Estimates of the total amount of PCB-containing fluids (plus solvent rinse) from the mandatory phaseout of PCB capacitors and askarel transformers (3.2 million gallons)

- The total volume of PCB-contaminated fluids removed from failed mineral oil transformer units (34.7 million gallons).

All of the PCB-containing fluids were assumed to have PCBs in excess of 500 ppm, while only 1.1 percent of the PCB-contaminated fluids contained PCBs above that concentration. All this volume must be incinerated under current regulations. An additional 11.8 percent of the PCB-contaminated fluids were assumed to contain 50 to 500 ppm PCBs. Of this volume, 90 percent was assumed to be incinerated with the remainder sent to landfills and/or treatment facilities.

From PCB capacitors, askarel transformers, and failed mineral oil transformers, therefore, a total of 7.3 million gallons of PCB fluids is estimated to be available annually for incineration. This left a difference of 1.6

EXHIBIT 9
Estimated Incineration Capacity Utilization For PCBs[a]

ESTIMATED DEMAND

TOTAL QUANTITY OF PCB FLUIDS	PERCENT CONTAINING <500 ppm, PCBs	PERCENT CONTAINING >500 ppm PCBs	PERCENT INCINERATED	TOTAL QUANTITY INCINERATED	
use phaseout of PCB capacitors/askarel transformers					
3,196,118 gallons		100%	100%	3, 196,118	
replacement/failure of contaminated mineral oil transformers					
34,726,852 gallons		1.1%	100%	381,995	48,368 metric tons/yr
	11.8%		90%	3,687,992	
carryover volumes from storage					
1,633,607 gallons[b]		100%	100%	1,633,607	@ 184 gal/MT

ESTIMATED CAPACITY

TOTAL PCB INCINERATION CAPACITY	TOTAL COMMERCIAL PCB INCINERATION CAPACITY	PERCENT OF CAPACITY FOR LIQUIDS	TOTAL CAPACITY FOR LIQUIDS PCBs
57,415 metric tons PCB fluid/yr	53,742 metric tons PCB fluid/year	90%	48,368 metric tons PCB fluid/yr

CAPACITY UTILIZATION
100%[c]

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a) See also Appendix C.

b) With industry sources indicating at or near 100 percent capacity utilization for PCBs, carryover volume determined determined from difference of estimated capacity minus estimated demand from use phaseout of PCB capacitors/transformers and replacement/failure of mineral oil transformers.

c) Determined from conversations with industry sources. Used to establish total estimated demand.

million gallons from the 100 percent capacity utilization estimate of 8.9 million gallons. Lacking another suitable estimate, this additional 1.6 million gallons was assumed to come out of the volume of liquid PCBs in storage.

Perhaps the most uncertain assumptions in this analysis are those on the rate of use phaseout for PCB capacitors and askarel transformers (and the PCB fluid volumes that result). Phaseout rates used in EPA's reports (and used here) have been criticized as not taking into account the accelerated voluntary phaseout of these equipment. Industry sources consulted indicate that the phaseout rate is higher than has been predicted due to these voluntary programs. These sources argue that the PCB fluids volume may be two to three times greater than the 3.2 million gallons estimated from the 1982 PCB Use Rule RIA data (13). If so, and assuming near full use of available PCB incineration capacity, this would indicate that large quantities of PCB fluids are in storage awaiting handling, and that PCB incineration demand greatly exceeds available incineration capacity at least for the next three to four years.*

Commercial incineration firms stress the major influence of PCB incineration demand towards higher market prices and less capacity available for non-PCB incinerable liquid wastes. Over the short-term, this large demand may dictate the ability of the incineration industry to respond (as well as the cost to generators) to added LOHW volumes brought about by regulatory change. Better estimates of this demand are needed.

3. INCINERATION DEMAND: INFLUENCE OF SUPERFUND CLEAN-UP ACTIVITIES

In recent months, there has been considerable interest in looking at how Superfund activities, both removals and remedial cleanups, may affect RCRA waste management capacity. How large on influence these activities may have on commercial incineration capacity is the subject of a module for this market analysis.

No estimate of total quantities of waste sent to RCRA facilities from Superfund removal and remedial sites is directly available. The data exists, but the data base is fragmented, distributed across several sources, and frequently lacks the detail needed for a market analysis.

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* Chapter IV also discusses projections of PCB incineration demand, and examines possible increases in incineration capacity for liquid PCBs.

Quantities of wastes sent off-site may be recorded, for example, but little information is available as to the specific composition of these wastes. In other cases, the quantity information may be very sketchy.

Currently, there are efforts to compile and evaluate the available data. Some preliminary estimates do exist. Data compiled by Booz, Allen for 30 remedial sites, for example, indicate that 178,000 metric tons of wastes were excavated and sent off-site for disposal in landfills. If as much as 15 percent of these wastes were incinerable liquids, these volumes, if incinerated, would utilize 11 percent of commercial incineration capacity available nationwide, perhaps more on a regional basis. How much of these wastes were liquids and incinerable or how much waste from these sites was sent off-site for treatment (including incineration) is not known. Even less is directly known about quantities of incinerable wastes sent off-site for handling from removal sites.

What may happen from future Superfund activities is, of course, difficult to estimate, but given current trends the waste quantities may be quite large. Few remedial sites have been completed, for example, and the number of National Priorities List sites is growing. Estimates of the potential number of hazardous waste sites range as high as 20,000. As yet, commercial incineration firms and waste management firms as a whole report little overall impact on capacity from receipt of Superfund wastes (10). On a seasonal basis, management of Superfund wastes does occasionally lead to delays in handling non-Superfund wastes, as Superfund responses tend to be concentrated in the months of May through October. These firms comment, however, that if Superfund responses are accelerated and spread out throughout the year, and if land disposal restrictions and regulations for the management of dioxin-contaminated wastes are enacted, then available incineration capacity for Superfund wastes may be a significant concern.

4. INCINERATION DEMAND: BASELINE WASTE QUANTITIES MANAGED IN LANDFILLS, INJECTION WELLS, BOILERS AND DISPOSAL IMPOUNDMENTS

Each of the regulatory amendments analyzed in Chapter IV is built upon baseline estimates of the quantity of hazardous wastes managed, on-site and off-site, in landfills, boilers, injection wells, and disposal impoundments. It is these baseline conditions that are expected to shift as regulatory changes move LOHWs out of these technologies to incineration. Both on-site and off-site baseline conditions must be estimated as generators may elect to increase or reduce their on-site waste management activities in response to these regulatory changes.

Exhibit 10 shows the baseline mid-, low-, and high-range estimates calculated for wastes managed on-site and off-site by technology. The starting points for these estimates are the RIA National Survey estimate of 264 MMT of wastes generated in 1981 (2) and preliminary results from the EPA's Boiler Survey (15). RIA National Survey data were also used to calculate what percentage of all wastes generated were managed in landfills (1.2%), injection wells (12.1%), and disposal impoundments (7.2%).

The key assumption in these baseline calculations is the on-site and off-site distribution of the wastes managed by technology. For the baseline estimates of wastes injected in wells or disposed in impoundments, the on-site/off-site split is derived from an analysis of data drawn from the RIA National Survey (see Appendix B). These splits do not vary across the three sensitivity analysis cases as no other sources offered an alternative distribution (i.e., the sensitivity analysis cases for these two scenarios reflect variations in other assumptions). The on-site/off-site split does vary across the low-, mid-, and high-range estimate cases for wastes managed in landfills. The low-range case distribution of 43 percent on-site and 57 percent off-site is derived from the analysis of the RIA National Survey data. The high-range case of 16 percent on-site and 84 percent off-site reflects a comparison of the 3.2 MMT of wastes managed in landfills in 1981 according to the Survey with independent estimates that 2.7 MMT of wastes were managed in commercial landfills in 1980 (7, 12, 16). The mid-range case represents an average case relative to these possible upper and lower bounds. All three sensitivity analysis cases become baselines, therefore, against which the incremental change in demand due to RCRA regulatory change can be measured. These possible incremental changes in the demand for incineration capacity are examined in the next chapter.

EXHIBIT 10

Baseline Mid-Range Estimates Of Hazardous Wastes Landfilled, Injected Into Wells, Disposed In Surface Impoundments[a]

TOTAL QUANTITY OF WASTES GENERATED	PERCENT OF WASTES GENERATED GOING TO:	TOTAL QUANTITY OF WASTES:	ONSITE/OFFSITE SPLITS	TOTAL QUANTITY OF ONSITE WASTES:	TOTAL QUANTITY OF OFFSITE WASTES:
		LANDFILLS			
264 million metric tons/yr	1.2%	3.2 million metric tons/yr	30% onsite 70% offsite	0.95 million metric tons/yr	2.22 million metric tons/yr
		INJECTION WELLS			
264 million metric tons/yr	12.1%	31.9 million metric tons/yr	97.5% onsite 2.5% offsite	31.1 million metric tons/yr	0.8 million metric tons/yr
		DISPOSAL IMPOUNDMENTS			
264 million metric tons/yr	7.2%	19 million metric tons/yr	95% onsite 5% offsite	18.06 million metric tons/yr	0.95 million metric tons/yr

a) See also Appendix C

IV. PROJECTED CHANGES IN INCINERATION DEMAND AND CAPACITY UTILIZATION

On-site and off-site incineration demand is expected to increase even in the absence of the regulatory changes to RCRA the EPA expects to implement. If the land disposal restrictions, and other regulatory amendments are implemented, however, the shift of LOHWs to incineration is projected to be even greater. How much greater these shifts could be, over the very short-term, with and without anticipated changes to the RCRA regulations is the subject of this chapter.

1. PROJECTED INCINERATION DEMAND WITHOUT REGULATORY CHANGE

Commercial incineration firms forecast a growing market for their services over the next three to five years, even if the current RCRA regulations are not modified substantially. Their reasoning is fairly consistent across larger and smaller firms and whether or not incineration is their sole service or one of several waste treatment/ disposal services. These firms cite several factors behind their short-term projections:

- Increasing demand for PCB incineration capacity
- Slowed commercialization of alternative technologies
- Questionable responsiveness of "available" on-site incineration capacity
- Declining landfill capacity
- Increased Superfund clean-up activities and Superfund policies that encourage incineration
- Generators' increasing liability concerns.

Generally, these factors are seen to increase the short-term demand for incineration services by anywhere from 5 to 20 percent. All things being equal, incineration firms seem to feel that present unused incineration capacity nationwide and the expected growth in capacity will be able to handle this demand. Several firms hint that regional capacity, particularly in the West and Midwest, may be a problem* but they provide few specifics (i.e., little quantification) behind their hy- pothesis.

Longer-term market forecasts in the absence of regulatory changes are less definitive. PCB incineration demand (for fluids containing more than 500 ppm PCBs) is seen to decline as the mandatory phase-out deadlines are reached. Competition from alternative innovative technologies (both thermal and non-thermal) is considered hard to judge five to ten years out. Similarly, there are significant uncertainties to how successful generators will be in reducing waste generation, or to how big a move there might be to increased on-site incineration of liquid wastes.

Each of these factors are discussed generally in the following sections.

(1) Demand for PCB Incineration Capacity

Commercial firms permitted to burn PCBs see a large, but short-term growth potential for incinerating PCB - contaminated products with PCBs in excess of 500 ppm. These products would be fluids from PCB capacitors (as well as the capacitors themselves in some cases) and askarel transformers that must be incinerated under the current regulatory framework. Most believe that EPA's estimates of the PCB phase-out volumes to be handled as too low. these firms see users of PCB-containing equipment greatly accelerating their phase-out of equipment voluntarily above the minimum rate necessary to meet the mandated deadlines. This accelerated phase-out rate means, however, that this market is expected to remain strong for only another three to four years. Whether the market continues to be strong beyond that point is seen to depend on how owners of PCB-containing equipment with PCBs in the 50 to 500 ppm concentration range choose to handle these PCB fluids, and which treatment/disposal options remain open to them. If restrictions on burning hazardous wastes in boilers act to limit the practice of burning these fluids in industrial/utility boilers, and/or if PCBs are prohibited from landfills, then the incineration market for PCBs may remain fairly strong for the next 25 years according to some industry projections.

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* The reasons behind possible shortfalls in capacity in these two regions differ. In the West, the issue is apparently few commercial facilities. In the Midwest the demand for PCB incineration is seen to be so great as to limit the availability of capacity for non-PCB, liquid wastes.

(2) Availability of On-site Capacity

Whether the demand for commercial incineration services grows may depend upon the availability and expandability of on-site incineration capacity. Few sources reviewed for this study, however, could provide a definite fix on available on-site incineration capacity for LOHWs. Based upon the data available, current on-site capacity utilization may range from 27 to 54 percent. While there may be capacity available, how the remaining capacity is distributed regionally and whether the operating economics and size of these on-site incinerators preclude increased use is unknown. There are simply not enough data on on-site capacity to resolve these unknowns.

Whatever the current utilization of on-site incineration capacity, however, many commercial firms believe that few generators can and/or desire to go through the regulatory process to permit greater use of their existing capacity or to expand that capacity. Many of the commercial firms cite regulatory complexity, costs, and delays as a critical limit on their ability to expand services. They stress that these problems may be more limiting for a generator, particularly the smaller to mid-size generators. This hesitancy, however, could be countered over the longer-term by a generator's increasing concerns over the potential liabilities associated with off-site treatment/disposal.

How a particular generator will balance these issues either in favor of or against on-site management of its wastes is not easy to predict. Available resources (includes having an existing site), corporate philosophy and image, and the type of operation or business will all influence that choice. For some generators, like some major chemical companies, on-site waste management will be seen as a natural extension of their capabilities and experience, and these will be the resources available to construct the necessary program and facilities. Other chemical companies may share the same corporate philosophies and basic expertise, but the variety of their production lines and, therefore, their wastes may preclude building sufficient capacity. In these cases, their option would be to scrutinize commercial waste management facilities carefully against specified acceptance criteria. This practice can be seen at work in the commercial waste management industry. Still other major waste generating industries (e.g., the automobile industry) may not have the requisite experience or interest in developing on-site waste management capabilities, and will also elect to care- fully select commercial waste management services.

Such considerations are also important in the analyses to follow in the next section on projected demand for incineration capacity under each regulatory scenario. In each scenario, there is an assumption that the incinerable fraction of the wastes affected by the restrictions may move on-site or off-site in order to be incinerated. Most of the wastes (95 percent) originally being managed at commercial facilities are assumed to remain at commercial facilities to be incinerated, while the majority of the wastes (60 percent) originally managed on-site move off-site to be incinerated at commercial facilities. This latter assumption reflects the judgment that, on the margin, most generators will elect to have commercial facilities incinerate their wastes.

(3) Commercialization of Alternative Technologies

There are several alternative* thermal waste management technologies that are options to both land-based incineration and at-sea incineration. How quickly these technologies break into the commercial waste management market, become permitted, and establish sufficient capacity are the principal determinants of their competitive threat.

The "commercialization rate" for emerging alternative thermal technologies was the subject of a separate study by the EPA's Office of Research and Development (ORD) (17). Over 50 processes were reviewed by ORD; of these, 20 were reviewed in detail. Only 11 of the 20 were rated usable to treat or destroy the LOHWs of concern in the market study (see Exhibit 11). These 11 processes were considered to offer the "greatest relative potential to affect waste management practices over the next five years."

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* As differentiated from conventional incineration processes.

EXHIBIT 11
Alternative Thermal Technologies Judged Suited To "Destroy" Liquid Organic Wastestreams

THERMAL/PYROLYTIC TECHNOLOGY	LIQUID ORGANIC WASTESTREAMS[a]										
	D001	D002	D003	F001	F003	F005	K049	K051	U122	PCB	ASKARELS
HIGH TEMPERATURE FLUID WALL	▨			▨	▨	▨			▨	▨	▨
MOLTEN SALT	▨										
WET AIR OXIDATION				■	■	■					
PLASMA ARC	▨			▨	▨	▨	▨	▨	▨	▨	▨
ROTARY PYROLYZER				▨	▨	▨		▨			
LOW TEMPERATURE FLUID WALL				▨	▨	▨			▨		
ADVANCED ELECTRIC REACTORS	▨			▨	▨	▨					
CATALYTIC DEHALOGENATION				▨	▨	▨					
HIGH TEMPERATURE PYROLYSIS	▨			▨	▨	▨	▨	▨	▨	▨	▨
THERMAL PLASMA PROCESS	▨			▨	▨	▨					
CORONA GLOW PROCESS	▨			▨	▨	▨					
FLUID PHASE OXIDATION	▨			■	■	■					
CIRCULATING BED INCINERATION	▨			▨	▨	▨	▨	▨			
AQUEOUS PHASE ALKALINE				■	■	■					
MOLTEN GLASS INCINERATION	▨			▨	▨	▨	▨	▨	▨	▨	▨
FLUID BED (POWER RECOVERY)	▨			▨	▨	▨	▨	▨	▨		
SUPERCRITICAL WATER				■	■	■					
CATALYZED WET OXIDATION				■	■	■					
MICROWAVE PLASMA				■	■	■					

[a] Waste types selected as "representative" by ORD.

▨ "Destroys" waste

■ "Destroys" waste in aqueous solutions

SOURCE: (20)

While the draft ORD report did not forecast commercialization rates per se, some statements on commercial availability were made. Many of the processes discussed "are or will soon be available commercially." None of them, however, were considered able to significantly "affect the overall adoption of thermal treatment technology over the next five years." Any changes would likely be "accumulated gradually." As to the scale of these changes, that is, to what degree will on-site or commercial thermal treatment capacity change, no estimate is provided in the ORD report.

Some benefits from commercialization of these alternative technologies are noted by ORD. Many are designed to offer more effective and efficient destruction of LOHWs over conventional processes, or operate at such high temperatures that the more difficult-to-destroy wastes can be handled. The scale of some designs also make them more mobile allowing transportation to the site.

Industry sources asked to comment on the commercialization rate of alternative technologies cited no specifics, but indicated generally that they perceived the rate as "slow." Many firms feel that established incineration processes enjoy a regulatory advantage over emerging technologies. They perceive permitting complexities and costs as limiting, at least, the marketability of innovative processes, if not limiting innovation itself.

(4) Declining Landfill Capacity

While there are several large landfills with significant remaining life-time capacity, there have been several site closures. In these cases, sites have reached capacity, or active sites have been closed voluntarily or through regulatory action. The rate of future site closures is difficult to predict, but it is clear that the addition of landfill capacity will be, at best, slow (due to regulatory disfavor, public opposition to siting, and so forth). This has led commercial incineration firms to speculate that net landfill capacity will decline, and that the commercial incineration market should grow as a result.

(5) Superfund's Influence

Two significant influences on incineration market growth are linked, by both generators and waste management firms, to the Superfund program. The first, covered in Chapter II, is the potential for Superfund clean-up activities to present added volumes for incineration. The second, and perhaps most influential over the longer term, is the interaction of RCRA and Superfund to increase generators' perceptions of and concerns over the liabilities of off-site disposal of their wastes (18). Even if it is permitted legally, the impermanancy of land disposing wastes is being perceived increasingly as open to potentially costly liabilities either in terms of dollars, image, or both. These negatives are viewed as considerably less likely when the wastes are incinerated properly. Commercial firms feel strongly that it is this "risk equation" that drives more generators to pay the higher up-front costs to incinerate their highly toxic wastes.

In the absence of regulatory change, therefore, the strong perception is that the demand for on-site and commercial incineration capacity will increase. Exactly how much this increase might be cannot be estimated from the data available. Some guesses place the increase as considerable, that is, as much as 20 percent over current demand levels. Others figure the balance of market influences as too close to call, and see a much more modest increase (5 percent). There are signs of at least some market growth, however, growth that can only benefit from some of the regulatory changes being considered by the EPA.

2. PROJECTED INCINERATION DEMAND AND CAPACITY UTILIZATION WITH REGULATORY CHANGE

The projections of market growth if RCRA regulatory changes are implemented immediately are nearly unanimous: increased demand over the shortto mid-term with on-site and commercial incineration capacity unable to meet the demand. All industry sources contacted see the RCRA regulatory changes as a "boon" to the commercial incineration market. In fact, the anticipation that these changes will occur is already sparking a "marked increase" in wastes available for incineration. The LOHW incineration market is seen as becoming increasingly competitive with those waste management technologies that have historically enjoyed a competitive edge in costs.

How successfully the commercial incineration firms will be able to meet the added demand is more speculative. If existing capacity is available and regulatory changes are phased in gradually, the consensus is that the market could be able to meet the demand. Commercial waste management firms are planning now to add capacity, particularly rotary kilns, but the three to five year, regulatory-induced, lag time for bringing new capacity on-line means that there must be sufficient lead time. If capacity utilization is underestimated, and if the regulatory changes are strict and enacted too rapidly, however, capacity shortfalls are projected as likely. The influence of these factors are examined specifically in Chapter VI.

Each of the following analyses attempt to estimate possible outcomes of several RCRA regulatory amendment scenarios as measured by incineration capacity utilization (on-site and commercial) assuming no increase in capacity. Each "futures" analysis is based on one or more of the baseline market estimates developed in Chapter III. Each scenario has also been evaluated by means of a sensitivity analysis with development of low-range, mid-range, and high-range estimate cases. The logic diagrams in Appendix C trace the analysis for the mid-range case designated here as the most likely outcome. Appendix D summarizes those key data and assumptions varied as part of the lowand highrange cases.

The RCRA regulatory amendment scenarios analyzed include:

- Restrictions on the land disposal of LOHWs (landfills, deep well injection, and disposal impoundments)
- Restrictions on burning and hazardous wastes in boilers/furnaces
- Additional listings of organic liquids as hazardous wastes.

The regulatory amendment scenarios were developed by or in consultation with EPA staff. While these scenarios reasonably reflect Agency thinking, they are not formal Agency positions nor necessarily how the draft regulations might appear. They are intended solely to speculate on possible outcomes covering a range of options built into the sensitivity analysis.

(1) Land Disposal Restrictions

Three different forms of restrictions on the land disposal of LOHWs are examined:

- Restrictions on landfilling LOHWs whose constituents exceed specified concentrations

- Restrictions on deep well injection of LOHWs
- A ban on disposing LOHWs in surface impoundments.

Each land disposal restriction is evaluated separately for its impact on on-site and commercial incineration capacity utilization.

1. Landfill Restrictions

The reauthorization of RCRA, passed by Congress and recently signed by the President, direct the EPA to prohibit the landfilling (or other land disposal) of hazardous wastes when this practice does not protect human health and the environment. Potential waste candidates for the ban are specified as well as the schedule for evaluating all wastes against the prohibition decision rule. Other restrictions apply to liquids in landfills. Variances to the prohibitions are allowed for limited periods if alternative waste management capacity is unavailable. Otherwise, the prohibitions are effective immediately.

Estimates of how much waste currently landfilled would ultimately be affected by these prohibitions range from 25 to 75 percent of current totals. The range reflects uncertainty over which wastes would eventually be prohibited, and whether pretreatment to make the waste substantially less toxic or less mobile could be accomplished to allow these wastes to still be landfilled. The EPA, in some preliminary analyses of the restrictions, assumes that 50 percent of the wastes now landfilled might be affected.

The landfilled restrictions scenario developed for the market analysis examines how much waste, now landfilled, might move out of landfills to be incinerated at commercial facilities. The scenario is built upon the three baseline estimate cases for wastes now landfilled (see Chapter III) that reflect variation in the estimated percentage of wastes landfilled on-site and at commercial facilities. In estimating the possible impact of the landfill restrictions, variations in the percent of landfilled wastes affected are built into the low-, mid-, and high-range estimate cases, as 25 percent, 50 percent, and 75 percent of all wastes landfilled, respectively.

Landfill restrictions affecting 50% of all hazardous wastes landfilled (the mid-range case) might increase net commercial incineration capacity utilization to 215% of present capacity. The influence on on-site capacity utilization is estimated to be far less, that is an increase from 40 to 43 percent of present capacity. These effects are based upon several additional key assumptions:

- Only thirty percent of the wastes affected by the restrictions are incinerated*
- On the margin, most (60 percent) of the incinerable, restriction-affected wastes once landfilled on-site move off-site to be incinerated (40 percent remain on-site to be incinerated)
- Nearly all (95 percent) of the incinerable, restriction-affected wastes landfilled off-site remain off-site to be incinerated (5 percent of these wastes are no longer sent off-site but return on-site to be incinerated).

Similar assumptions are applied in the low-range and high-range estimate cases.

The results of all three sensitivity analysis cases are shown in Exhibit 12. With only 25 percent of the wastes landfilled affected by the restrictions and an on-site/off-site distribution of wastes now landfilled of 43 and 57 percent, respectively, commercial incineration capacity utilization is estimated at 112% of capacity after the restrictions are implemented. If the percentage of wastes affected is as high as 75 percent with 84 percent of the wastes now landfilled off-site, commercial incineration capacity utilization is calculated to be 327% of

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* This assumes that the remaining 70 percent of the wastes are handled in other ways including resource recovery, waste reduction, pretreatment for landfilling, chemical treatment, and any other non-incineration method. This assumption was not varied in the sensitivity analysis as alternatives were not offered.

EXHIBIT 12
Effects Of Landfill Restrictions On Incineration Of Liquid Organic Hazardous Wastes--Mid-Range Case[a]

	Onsite	Offsite
Total Quantity Landfilled (Million Metric Tons/Yr)	0.95[b]	2.22[b]
Percent Of Wastes Affected By Landfill Restrictions	50%[c]	50%[c]
Percent Of Affected Wastes That Are Incinerated	30%[d]	30%[d]
Total Quantity To Be Incinerated (Million Metric Tons/Yr)	0.143	0.333
Quantity Incinerated After Estimated Onsite/Offsite Shifts (Million Metric Tons/Yr)	0.074[e]	0.402[e]
Baseline Demand For Incineration (Million Metric Tons/Yr)	1.253	0.139
Total Demand For Incineration (Million MEtric Tons/Yr)	1.327	0.541
Incineration Capacity For LOHWs (Million Metric Tons/Yr)	3.1	0.252[f]
Percent Capacity Utilization	42.8%	214.7%

a) See also Appendix C.
b) See Exhibit 10.
c) Estimates supplied by EPA staff ranged from 25% to 75%. Twenty-five percent and 75% taken as low-range and high-range cases, respectively, in sensitivity analysis (see Appendix D). Mid-range case = 50%.
d) Assumes that other waste management methods (e.g., pretreatment, source reduction) will be used in handling of remaining 70% of the waste.
e) Assumes that 40% of the on-site origin wastes stay on-site to be incinerated while 60% goes off-site, and that 95% of the off-site waste stayd off-site to be incinerated while 5% moves back on-site to be incinerated.
f) Is commercial incineration capacity net that estimated for liquid PCBs. See Appendix C.

capacity. Whatever the assumptions, therefore, one outcome of this scenario analysis appears to hold true. Landfilled restrictions are likely to make available for incineration a sufficient volume of wastes to consume remaining unused commercial capacity and leave the demand for commercial incineration capacity for LOHWs above current supply.

2. Injection Well Restrictions

Restrictions on deep well injection of hazardous wastes are also called for in the RCRA reauthorization. Analysis of this scenario projects a similar, if not a greater, impact as the landfill restrictions. As much as 74 percent of available on-site incineration capacity and 450 percent of available commercial incineration capacity could be utilized under the high-range case. The effect on both on-site and commercial incineration capacity utilization is considerable as the quantity of wastes injected into wells is estimated to be quite large (32 MMT). Even a small percentage of this volume (6.5 percent) translates into a large quantity of waste.

Exhibit 13 details the major sensitivity analysis assumptions of the deep well injection scenario. As with the landfill restrictions scenario, the low-range, mid-range, and high-range estimate cases for the deep well injection scenario reflect a range of 25 to 75 percent in the percentage of wastes affected by the restrictions. As the most likely case, the mid-range case estimates that 50 percent of the wastes are affected. This would result in a demand for commercial incineration capacity of 306% of present capacity, and a demand for on-site incineration capacity of 54% of present capacity. Results of the low-range case are 162% and 34% of commercial and on-site capacity, respectively. As noted, assuming that 75 percent of the wastes are affected (the high-range case) is projected to result in a demand for commercial incineration capacity of 450% of current capacity.

Each sensitivity analysis case assumes that not all of the restriction-affected wastes would be incinerable, in fact, each analysis assumes that 65 percent of the restricted wastes would not be incinerable. Thirty percent of the restricted wastes would have to be pretreated to be

EXHIBIT 13

Effects Of Restrictions On Deep Well Injection: Major Analytical Assumptions For Mid-Range Case[a]

PERCENT OF INJECTED WASTES AFFECTED	PERCENT OF AFFECTED WASTES THAT ARE NOT INCINERABLE	PERCENT OF AFFECTED WASTES THAT ARE DIRECTLY INCINERABLE AND ARE INCINERATED	PERCENT OF AFFECTED WASTES THAT ARE INDIRECTLY INCINERABLE	INDIRECTLY INCINERABLE WASTES AFTER PRETREATMENT	
				PERCENT INCINERABLE AND INCINERATED	PERCENT NOT INCINERABLE
50%	65%[b]	5%[c]	30%[d]	5%[e]	95%[e]

TOTAL INCINERABLE AND INCINERATED = 6.5% OF ORIGINAL VOLUME AFFECTED

a) See also Appendix C

b) Assumes that majority of wastes injected are either not incinerable or cannot be made (i.e., treated to be) incinerable, and will be managed by other means.

c) Assumes that only 5% of affected wastes are directly incinerable (i.e., no treatment needed) and are incinerated.

d) Assumes that a fraction of the affected wastes can be made incinerable with pretreatment.

e) After pretreatment, most of wastes are not incinerable (i.e., water or dilute streams) and only a small percentage is incinerable and incinerated. Non-incinerable fraction is managed by other means.

made incinerable, leaving only 5 percent of the original volume of these indirectly incinerable wastes as actually incinerated (assumes that 95 percent of the initial volume is water). An additional 5 percent of the restricted waste is assumed to be directly incinerable.* Of the original total volume of restricted wastes previously injected, therefore, only 6.5 percent actually becomes available for incineration. This reasoning is applied to wastes injected into on-site and commercial wells (most wastes, 98 percent, are assumed to be injected into on-site wells. Most of this incinerable volume is incinerated at commercial facilities (95 percent of the affected wastes originally injected off-site and 60 percent of the affected wastes originally injected on-site).

In sum, possible restrictions on deep well injection of hazardous wastes are hard to evaluate. Exactly how such restrictions would operate is not certain as the capacity to pretreat these frequently very dilute, very large volume aqueous wastes is not known. These wastes may be incinerable, but the EPA does not know of any technology capable of handling the large volumes of wastes economically. The scenario analyzed shows, however, that commercial incineration capacity could be exceeded easily if only 1 percent of the 32 MMT of wastes injected were incinerable and incinerated at commercial facilities.

3. Disposal Impoundment Ban

Amendments to RCRA would extend land disposal prohibitions to the disposal of hazardous wastes in surface impoundments. Assuming that facilities that treat and/or store wastes in surface impoundments would operate to preclude disposal of wastes in these impoundments, this amendment would preclude the practice of disposing wastes in surface impoundments, so-called disposal impoundments.

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* While some fraction of injected wastes may be directly or indirectly incinerable, this fraction may be far less than the assumed 5 percent, respectively. The EPA indicated in their Task 1 report that they "do not have adequate information on commercially feasible pretreatment and volume reduction of these wastes" to believe that this could occur on a sufficiently large scale (1).

The impact of a ban on the disposal of hazardous wastes in surface impoundments on commercial incineration capacity is hard to predict. There are many uncertainties and weaknesses in the available data. Primary among these is the estimate that 10 percent of the wastes placed in disposal impoundments are incinerable.* Of these incinerable wastes, the scenario assumes that either 25 percent, 50 percent, or 75 percent are actually incinerated. These options constitute the range of values suggested for this assumption as incorporated into the low-, mid-, and high-range cases of the sensitivity analysis.

With 50 percent of the incinerable, restriction-affected wastes actually incinerated, commercial capacity utilization is estimated to be 288% of current capacity. This compares to 153% of capacity for the low-range estimate case and 423% of capacity for the high-range estimate case. Similar calculations for on-site incineration capacity utilization range from 33 to 72 percent of capacity with 52 percent of capacity as the mid-range result. These estimated impacts are comparable to those calculated for the deep well injection restrictions scenario.

(2) Waste-in-Boilers Restrictions

According to EPA estimates, some 924 million gallons of waste-derived fuel materials were burned in about 2,800 industrial boilers and furnaces* in 1983 (15, 19).

These data also show that, by type, most waste-derived fuel materials were non-solvent, non-aqueous organic wastes and solid residues. Exhibit 14 shows the percentages of waste-derived fuel materials by type taken from preliminary Boiler Survey results.

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* It should be noted that the scenario analyzed concerns a ban on future waste disposal in impoundments rather than cleaning up old disposal impoundments. The estimate that 10 percent of the wastes sent to disposal impoundments are incinerable is based upon a comparison of 1981 RIA National Survey data on the volumes of LOHWs in disposal impoundments (456.5 MMT) with the volume of all wastes in disposal impoundments (4,012 MMT) (see Appendix B, Exhibits B-7 and B-8).

As a subset of waste-derived fuel materials, hazardous wastes were burned in about 1160 devices. Preliminary data from the EPA's Boiler Survey indicate that, in 1983, at a minimum:

- Some 30 utility boilers burned 7,000 gallons of hazardous wastes
- About 188 non-industrial devices (mostly space heaters) burned 19,000 gallons of hazardous wastes
- About 945 industrial devices burned 153,000,000 gallons of hazardous wastes.

Concerns over the health risks of burning hazardous wastes in boilers has prompted Congress and the EPA to consider controls on this practice. When these practices are brought further under the RCRA Subtitle C regulatory umbrella, this may lead to a decline in waste-in-boilers activity and an increase in wastes available for commercial incineration. As such, a scenario analysis module was developed to estimate the magnitude and impact of this possible shift (see Appendix C).

The key questions appear to be how strict the waste-in-boilers regulations might be and how many boilers will be unable to comply (at a "reasonable" cost) with the standards imposed. The scenario analysis summarized in Exhibit 15 reflects the EPA's assumption that 35 percent of the boiler/furnace population burning hazardous wastes would be unable to comply based on their capabilities and the type of waste burned, and would choose to shut down. If only 75 percent of the wastes these devices burned becomes available for incineration and most (70 percent) of this volume moves to commercial units to be incinerated, commercial incineration capacity utilization might increase to 106 percent of existing capacity.

---

* There are actually a variety of devices that burn waste-derived fuel materials. These include industrial and non-industrial boilers, kilns, industrial furnaces, process heaters, space heaters, non-RCRA incinerators, and other combustion devices. Industrial boilers and furnaces are the focus here as they are estimated to burn nearly 75 percent of all waste-derived fuel materials (19).

EXHIBIT 14

Quantities of Waste-Derived Fuel Materials Burned By Type

MATERIAL TYPE	QUANTITY BURNED (10^a gallons)	PERCENT OF TOTAL
Aqueous inorganics	14	1.5
Aqueous organics	65	7.1
Organic solvents	67	7.3
Other organic wastes	321	35.1
Reactives	<1	0.1
Corrosives	57	6.2
Other solid residues	191	20.9
Other wastes	199	21.8
	914[a]	

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a) Number is less than the estimate of the total quantity burned in 1983(924 million gal.) because respondents reported only six materials.

Source: (15)

With only 30 percent of this volume moving to on-site incinerators, on-site capacity utilization would increase marginally to 42 percent of existing capacity.

The EPA's estimate of 35 percent reflects a belief that most boilers and furnaces already can achieve the destruction efficiencies and emission controls likely to be mandated or will do so at little cost. Some incineration industry sources contacted tend to agree, and some estimate that far fewer will be impacted (perhaps only 10 percent). However, there are those who disagree and place this estimate as high as 50 percent. These sources believe that few owner/operators of these devices will choose to bear the regulatory "costs" of continuing to operate even if they comply technically with regulations. This will be particularly true, they predict, if extensive waste testing and performance monitoring requirements are imposed. In the long run, it may be cheaper to send their wastes to commercial facilities than to establish the mandated programs and procedures that the commercial incinerator firms already have in place.

The sensitivity analysis for the waste-in-boilers module varies the percentage of wastes burned that becomes available for incineration from the devices that shut down. If only 50 percent of these wastes are incinerated, commercial incineration capacity utilization might only be 71 percent of capacity. The remainder of these wastes, it is assumed, would be handled by other means including, for example, resource recovery and waste reduction. Conversely, if all the wastes are incinerated, commercial incineration capacity utilization is estimated to be 142 percent of capacity.

(3) Additional Waste Listings

Another regulatory-induced influence on incineration demand would be additions to the list of hazardous wastes. This would bring more wastes into the RCRA scheme adding to volumes of hazardous wastes already handled at RCRA-permitted facilities. Depending upon how large a quantity of incinerable wastes this involved, commercial incineration capacity might not be sufficient.

OSW has estimated that a total of 1.2 MMT of organic liquids would be added from new waste listings as a result of the Industry Studies Program (20). Presently, 90 percent of these wastes are managed on-site. These on-site management practices consist of

EXHIBIT 15

Effects Of Restrictions On Burning Hazardous Wastes In Boilers On The Incineration Of Liquid Organic Hazardous Wastes--Mid-Range Case[a]

Total Quantity of Hazardous Wastes Burned In Boilers (Million Metric Tons/Yr)	0.7[b]	
Percent Of Boiler Population Affected By Restrictions	35%[c]	
Percent of Wastes From Affected Boilers That Is Incinerated	75%[d]	
Total Quantity Now Incinerated (Million Metric Tons/Yr)	0.184	
Quantity Incinerated		
. Onsite (Million Metric Tons/Yr)	0.055	(30% Of Total Now Incinerated)
. Offsite (Million Metric Tons/Yr)	0.129	(70% Of Total Now Incinerated)
Baseline Quantity Incinerated		
. Onsite (Million Metric Tons/Yr)	1.253	
. Offsite (Million Metric Tons/Yr)	0.139	
Total Quantity Incinerated		
. Onsite (Million Metric Tons/Yr)	1.308	
. Offsite (Million Metric Tons/Yr)	0.268	
Incineration Capacity		
. Onsite (Million Metric Tons/Yr)	3.1	
. Offsite (Million Metric Tons/Yr)	0.252[e]	
Percent Capacity Utilization		
. Onsite (Million Metric Tons/Yr)	42.2%	
. Offsite (Million Metric Tons/Yr)	106.3%	

a) See also Appendix C.
b) Is subset of 3.5 million metric tons/yr of waste-derived fuel materials burned in boilers according to the EPA's 1983 Boiler Survey.
c) As suggested by EPA staff from preliminary results of the Boiler Survey.
d) EPA staff suggested range of 50% to 100%. Seventy-five percent is mid-range.
e) Is commercial capacity net that estimated for liquid PCBs. See also Appendix C.

burning these wastes in boilers (39%), incinerating these wastes (25%), or recovering these wastes (17%).* Of the wastes managed off-site, most are sold to other firms (46%), recovered (39%), or incinerated (6%).* The data EPA supplied, however, does not indicate what fraction of these wastes are already handled at RCRA facilities.

Though these wastes are not presently listed as hazardous, it is assumed that most are handled at RCRA-permitted facilities. If so, the net effect on incineration demand after they are formally listed should be small. This presumes that most of the wastes would still be managed on-site. Any wastes sent off-site and incinerated probably would affect demand only by 5 percent. Even at the 80 percent baseline utilization figure, this would still leave excess off-site incineration capacity. Lacking more specific data, however, it is difficult to predict these effects.

One new waste listing contemplated may have a significant effect--the proposed listing of certain wastes containing chlorinated dioxins (CDDs), dibenzofurans (CDFs), and phenols, and their phenoxy derivatives. In particular, there is reason to believe the quantities of CDD- and CDF-containing wastes "generated" from CERCLA waste site clean ups may be quite large. These wastes are likely to be contaminated soils that will either have to be stored or treated on-site, or sent off-site to be incinerated, landfilled, or stored.

(4) Lowering the Small Quantity Generator Exemption

Little data is available for predicting the effect of this regulatory change on commercial incineration demand. Opinions vary as to how much more wastes would have to be managed. Some believe that the concern over potential liabilities already has prompted small quantity generators to send their wastes to RCRA facilities. Lowering the exemption, therefore, would have little net effect. Others believe that this is not the case and that waste volumes would increase considerably.

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* OSW has attempted to eliminate double-counting of wastes in these estimates.

In developing this analysis, EPA staff were not in the position to even predict the possible effects of a lowering of the small quantity generator exemption. Studies aimed at gathering data on this question are underway; some preliminary results indicate that the total quantity may be no more than 1 million tons. EPA staff and industry sources contacted do agree that any possible impact will be more significant on a regional basis, and that regional capacity shortfalls could occur.

* * * * *

Even given a series of generally conservative assumptions, four possible RCRA regulatory scenarios are estimated to have a major impact on off-site commercial incineration capacity utilization if implemented immediately. Lacking increases in available capacity, each of the four could result in increasing demand far beyond existing capacity. These amendments include:

- A ban on landfilling LOHWs
- Restrictions on deep well injection of LOHWs
- Restrictions on disposing LOHWs in surface impoundments
- Controls on burning hazardous wastes in boilers.

Each of the regulatory changes is viewed by the commercial incineration industry as a likely "boon" to their market. They feel strongly that liquids incineration will become increasingly competitive with alternative waste management technologies. Not all of the impetus for market growth will come from regulatory change, however. Industry sources see generators' increased awareness of the potential liabilities of improper waste disposal as a major market growth factor. Generators, conscious of experiences with the Superfund program, are turning to methods, such as incineration, that they perceive as less risky and less costly options over the long-term. Commercial incineration firms already report an increase in business motivated by this factor alone.

This market analysis demonstrates the possibility that existing commercial incineration capacity may be insufficient to accommodate increased demand. The next chapter examines specifically how much LOHW incineration capacity may increase over the short- to long-term.

V. PROJECTED CHANGES IN LOHW INCINERATION CAPACITY

The regulatory scenarios examined in the previous chapters are founded on two broad assumptions: each regulatory change is implemented immediately and LOHW incineration capacity does not increase. There are indications, however, that LOHW incineration capacity is increasing or could be increased given some pending developments.

This market analysis assumes there are four sources of additional available incineration capacity for LOHWs to meet any increase in demand. These are:

- Use of remaining commercial incineration capacity for liquids
- Shifts in the waste feed mix to burn less solids and sludges and more liquids
- Construction and improved operation of new land-based, liquids incineration facilities
- Development of commercial incineration-at-sea capacity.

1. INCREASED CAPACITY UTILIZATION AND NEW LAND-BASED CAPACITY

Over the short-term, usage of any remaining commercial LOHW incineration capacity would be the most likely market response. As noted in Chapter III, however, exactly how much commercial LOHW incineration capacity remains is unclear. The baseline market analysis' low-and mid-range calculations place existing commercial incineration capacity utilization anywhere from 37 to 55 percent, respectively. Industry sources suggest commercial incineration capacity utilization may be closer to 80 percent, and they indicate that commercial incineration capacity utilization for PCBs is at or near 100 percent (PCB incineration demand probably exceeds supply). Remaining commercial LOHW incineration capacity, therefore, may range anywhere from 20 to 60 percent of total net commercial capacity (0.252 MMT).

Alternatively, commercial incineration firms, faced with an increase in LOHWs available for incineration, may alter their current waste feed mix by burning less solids and sludges and more liquids. Solids and liquids capacity, particularly for a rotary kiln, is not exclusive. Capacity now devoted to solids can be switched to liquids. This would represent another short-term option that would make additional capacity available to handle an excess of demand over capacity. It would have to be assumed, however, that prices for burning the additional liquids would be sufficient to displace the solids market. A reference to Exhibit 6 in Chapter II shows that prices to incinerate non-highly toxic liquids would have to rise anywhere from $1.00 to $2.00 per gallon to displace solids and highly toxic liquids.

In Chapter IV, incineration industry sources were quoted as considering regulatory complexity and constraints as major impediments to market entry and/or the addition of new capacity. These sources estimate that a lag time of at least 3 years must be figured into any projection of added incineration capacity, longer if significant public opposition is encountered. They have figured this lag time, for example, into plans for several (as many as 10) new land-based facilities and/or units over the next 5 to 7 years. If true, this would indicate that new land-based incineration capacity would be only a mid- to long-term possibility. Unfortunately, no commercial firm contacted that indicated an intention to add units over the next few years was willing to provide capacity data.

2. DEVELOPMENT OF INCINERATION-AT-SEA CAPACITY

Development of incineration-at-sea capacity would increase total LOHW incineration capacity. Accordingly, a module was developed to estimate the currently available incineration-at-sea capacity.

Based upon information supplied by EPA staff and industry sources, some 247,000 metric tons per year of capacity is available with the three incineration ships now built(21). Most, if not all, of this capacity would be for liquid wastes. This compares to an estimated 300,000 metric tons per year of land-based incineration capacity for LOHWs (including PCBs). As shown in Exhibit 16, less than half of this capacity would be supplied by the two operating Vulcanus ships owned by Ocean Combustion Services, and the remainder by the Apollo I ship owned by At-Sea Incineration. Not included in Exhibit 16, however, are planned incinerator ships. These would include At-Sea Incineration's second Apollo vessel and an unknown number of ships/barges planned by Seaburn and Environmental Oceanic Services. While there was some data available to estimate the capacity represented by these additional ships, they were not included given that there is no comparable data for planned land-based incinerators.

The operational assumptions detailed in Appendix C and summarized in Exhibit 16 were developed in consultation

EXHIBIT 16
Incineration-At-Sea Capacity[a]

Incineration Vessel	Burn Capacity Per Voyage (Metric Tons)	Estimated Number of Voyages Per Year	Estimated Annual Capacity (Metric Tons/Yr)
Vulcanus I	3,600[b]	16[c]	57,600
Vulcanus II	3,600[b]	16[c]	57,600
Apollo I	6,000[d]	22[e]	132,000
			247,200[f]
			(0.247 million metric tons/yr)

a) See also Appendix C. Source: (21).

b) Estimated per unit throughput capacity of 1,650 gal/hr at 240 hours of burning and 10 lbs/gal; 2 units of Vulcanus I, 3 units on Vulcanus II with 2 operating per voyage.

c) Estimated turnaround time of 3 weeks (5 days intransit, 10 days to burn, and 5 days to reload) less one voyage per year.

d) Estimated per unit throughput capacity of 2,750 gal/hr at 240 hours of burning and 10 lbs/gal; 2 units on ship.

e) Estimated turnaround time of 2 weeks (2 days intransit, 10 days to burn, and 2 days to reload less 4 voyages per year.

f) Represents capacity for incinerator ships presently constructed. Are at least 3 additional planned vessels not included.

with staff from the Office of Water Regulations and Standards (OWRS) with some confirmation by industry sources. There are several uncertainties to these data, however, that could reduce the estimate of existing incineration-at-sea capacity. For example, the Vulcanus I, now operating in European waters, may not be moved to serve a U.S. market. This would reduce available existing incineration-at-sea capacity by nearly 25 percent. Secondly, the per voyage capacities estimated for each ship assume that each incinerator will operate at full throughput capacity without significant operating problems or downtime.

Another issue is just how many voyages to the burn site(s) each ship will be able to make per year. Each firm has estimated a theoretical per year maximum based upon their expected turnaround times. The figures shown in Exhibit 16 are downgrades of these maximums allowing for some operational and logistics problems. Even somewhat fewer trips may be made per year, OWRS estimates, due to these problems as well as possible seasonal limits on operations. How many ships will be allowed to operate at the burn site(s) at one time is also still unresolved. These questions are likely to be resolved when the incineration-at-sea regulations are issued in 1985.

* * * * *

The addition of existing incineration-at-sea capacity would nearly double the current commercial incineration capacity for LOHWs. This would reduce commercial capacity utilization after landfill restrictions (mid-range case) from over 215 percent of capacity to 108 percent. The estimated effect of restrictions on burning wastes in boilers (mid-range case) would drop from 106 percent of capacity to 54 percent.

The availability of additional land-based or incineration-at-sea capacity, therefore, is seen to offer some moderation of the capacity shortfalls anticipated. The key issue then becomes how rapidly this capacity is added to the off-site market. These types of issues are the subject of Chapter VI.

VI. IMPLICATIONS OF THE MARKET ANALYSIS

The regulatory scenario analyses in Chapters IV and V have assumed that any regulatory-induced changes in LOHW incineration demand occur quickly, perhaps within a 1 to 3 year period. Over that same 1 to 3 year period, regulatory-induced and market-induced changes in incineration capacity* are likely to be slower. As such, these instantaneous demand-supply comparisons project a demand on incineration exceeding present incineration capacity.

In this chapter, the increase in incineration capacity required to meet this full demand is translated into two measures of incinerator capacity equivalents. This analysis translates the projected impact of each regulatory scenario into the building of incineration facilities and ships. The building of a land-based incinerator or incinerator ship is, of course, the most tangible impact these regulatory changes may have, and the key process that will shape the market's response. Therefore, this approach provides a consistent basis for measuring the potential impacts of the regulatory amendments to RCRA.

In addition, this approach provides an alternative to an analysis that attempts to estimate the impacts of a phased regulatory implementation schedule. No clear guidance on a possible phased implementation and compliance schedule was available at the time of this analysis. The RCRA reauthorization legislation does allow for a delay before the prohibitions or restrictions would have to take effect, if the EPA Administrator determines that adequate capacity will not be available to handle an immediate promulgation of the regulations.**

It bears repeating that the reasonableness of this market analysis rests entirely on the reasonableness of the assumpitons and data used in the regulatory scenario analyses (Chapter IV). Every effort has been made, given the available data, to ground these analyses in realistic, supported assessments of the market and possible regulatory change. Yet, as discussed in Chapters III and IV, some of the data and assumptions cannot be confirmed as reasonable as there are significant unknowns or inconsistencies to resolve. Variations in these data/ assumptions have, therefore, been incorporated into a sensitivity analysis.

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* Capacity changes also have a regulation-dependent component. Development of incineration-at-sea capacity, for example, must await development of regulations, and increases in land-based incineration capacity are tied to a separate permitting process.

** Implementation of the regulation is distinguished here from development of the regulation itself. The RCRA reauthorization legislation does indicate how rapidly the EPA must act to develop the applicable regulations.

Exhibit 17 summarizes the results of estimated increases in the demand on incineration relative to available existing LOHW capacity under the four RCRA regulatory scenarios:

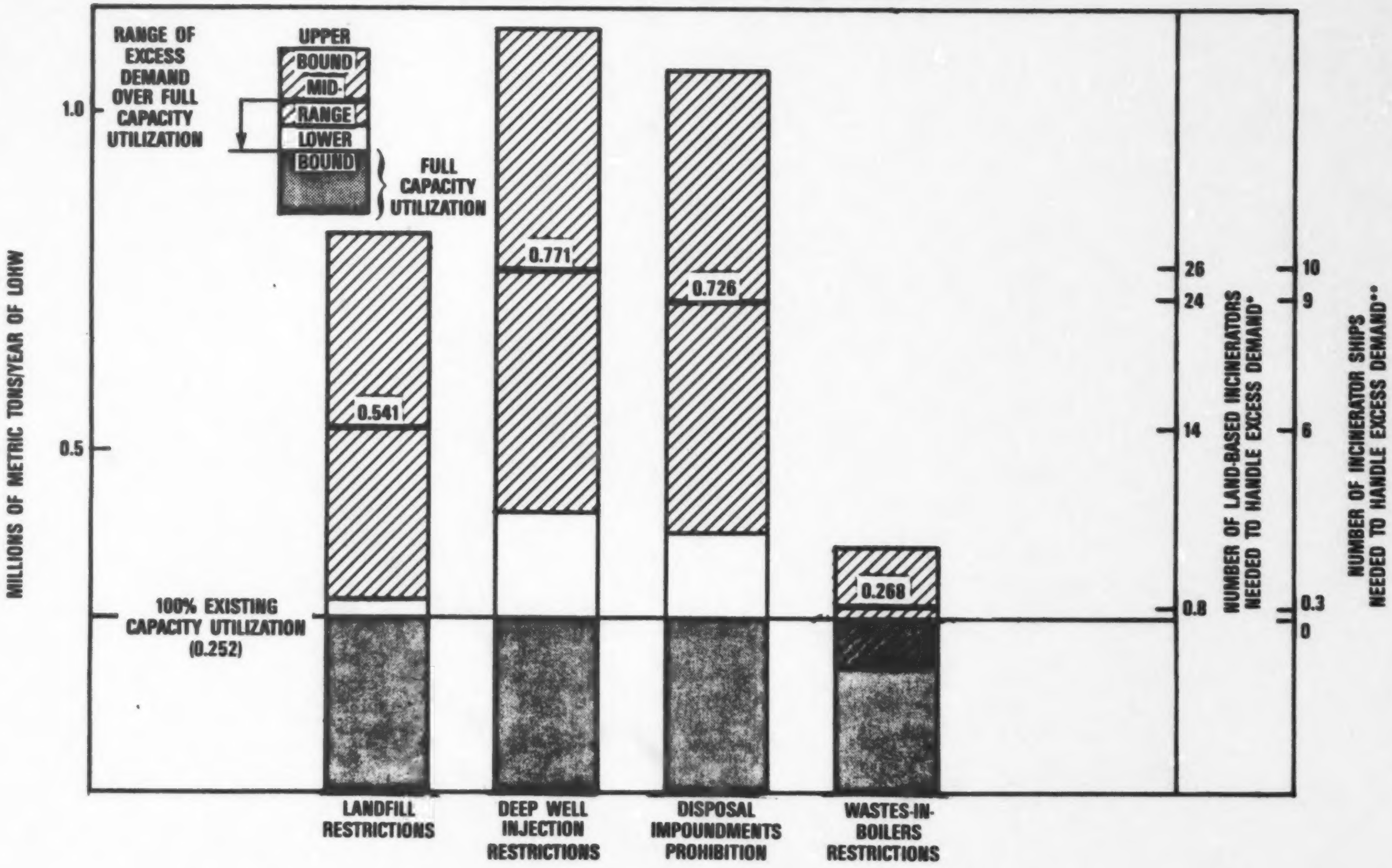
- Restrictions on landfilling LOHWs
- A prohibition on underground injection of LOHWs
- A prohibition on disposing LOHWs in surface impoundments.
- Restrictions on the burning of hazardous wastes in industrial boilers

The exhibit shows that, given the mid-range case assumptions, all four scenarios are estimated to increase the demand for incineration above existing commercial incineration capacity for LOHWs (fully utilized), significantly so for each of the three land disposal restrictions scenarios. All three land disposal restrictions scenarios are also projected to create an excess of demand over existing capacity given the low-range case assumptons. Only the low-range case for the wastes-in-boilers restrictions is estimated to leave the demand for incineration below existing available capacity.

If each scenario may lead to increasing the demand for incineration to levels exceeding available existing capacity for LOHWs, a logical question to ask is how much will commercial LOHW incineration capacity have to increase to match this demand. Exhibit 17 attempts to answer this question. On the one hand, the exhibit shows that some of the increase in demand will be accomodated by an increase in the utilization of existing commercial capacity to 100 percent. How much of an increase in commercial capacity utilization would depend on the baseline estimate capacity utilization. If present commercial capacity utilization is closer to the 80 or 90 percent level as some industry sources suggest, then the residual capacity available may not absorb much of the projected increase in demand.

EXHIBIT 17

INCINERATOR EQUIVALENTS ESTIMATED TO BE NECESSARY TO HANDLE THE EXCESS DEMAND FOR COMMERCIAL INCINERATION CAPACITY FOR LOHWs UNDER 4 REGULATORY SCENARIOS



*PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR NEW FACILITIES = 20,000 METRIC TONS

**PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR SHIPS = 50,000 METRIC TONS.

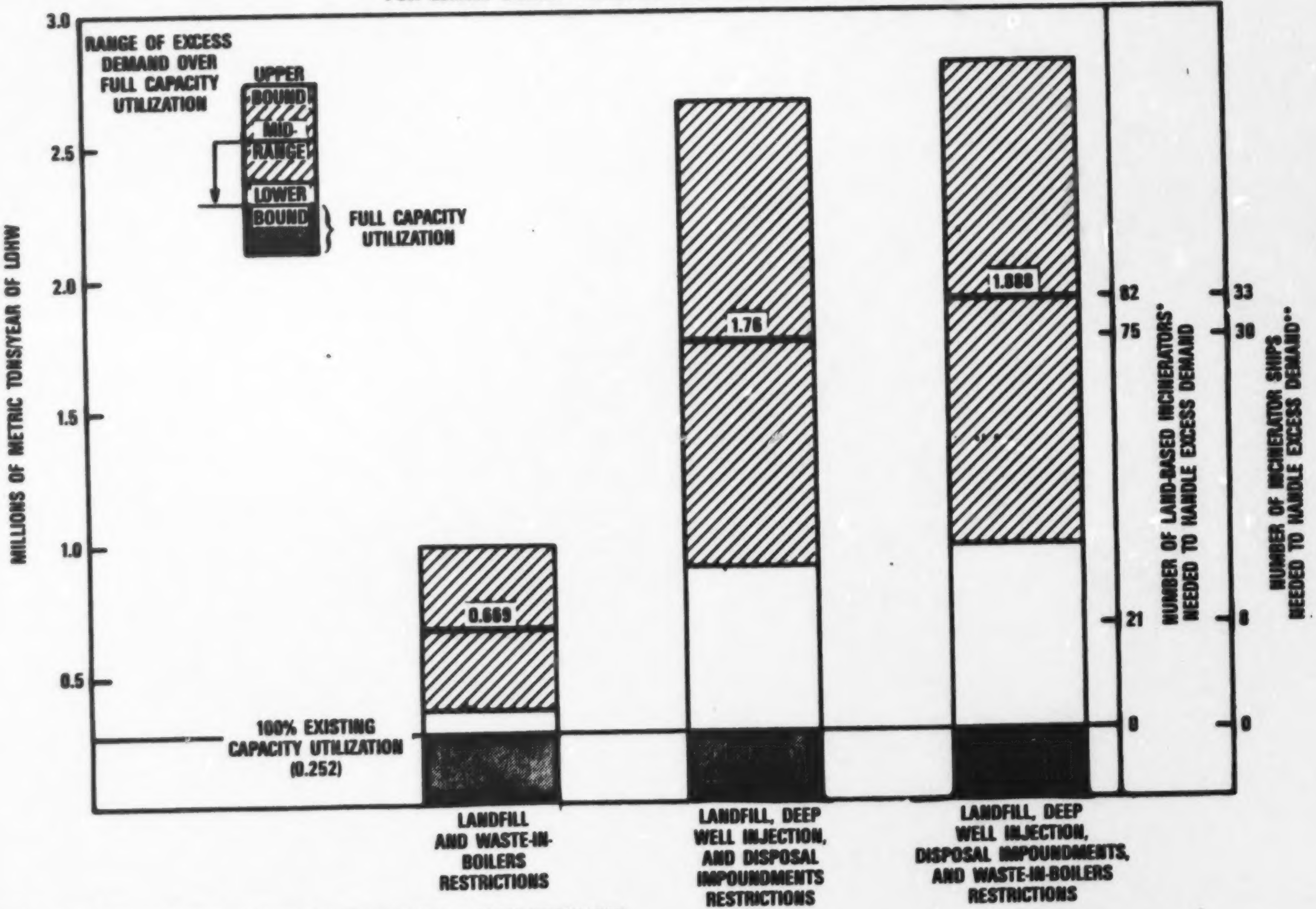
The key feature of the exhibit, however, is how any remaining excess demand over supply is translated into the two measures of incinerator equivalents--equivalent "average" capacity land-based incinerators and equivalent "average" capacity incinerator ships. For example, at full capacity utilization, landfill restrictions (mid-range estimates) are estimated to result in an excess demand of 0.289 MT (0.541 MT - 0.252 MT). In Exhibit 17, this difference is shown to be equaled by bringing on-line 14 additional land-based incinerator facilities (at a probable future average capacity of 20,000 metric tons per year per new facility) or 6 incinerator ships (at a probable future average capacity of 50,000 metric tons per year per ship). The largest impact a scenario may have in terms of incinerator equivalents is estimated to be 26 land-based facilities and 10 ships. This would be needed if all disposal of LOHWs in injection wells was prohibited (with only 6.5 percent of the affected wastes incinerated).

Given that several of these regulatory restrictions may be implemented concurrently by the EPA, Exhibit 18 examines the impact of combinations of the four regulatory scenarios. Again, any excess in the demand for incineration over existing available commercial incineration capacity for LOHWs (fully utilized) is translated into incinerator equivalents. The landfill and wastes-in-boilers restrictions (mid-range cases) considered together are projected to result in an excess of demand (0.669 MT - 0.252 MT = 0.417 MT) equivalent to 21 land-based incinerator facilities or 8 incinerator ships. All three land disposal restrictions (mid-range cases) are estimated to require 75 land-based incinerator facilities or 30 incinerator ships to handle the estimated excess demand. The addition of wastes-in-boilers restrictions to the three land disposal restrictions results in only a marginal increase to 82 land-based facilities or 33 ships.

Exhibit 18 also shows that the number of land-based facilities or ships needed could be far less or far greater than is estimated based on the mid-range case results. Not shown, however, are the results of mixing low-, mid-, and high-range case assumptions in each of the scenario analyses, or the possibility of using combinations of land-based facilities and ships to accomodate any projected increase in demand. Land-based facilities or ships with a larger average annual capacity than assumed in both Exhibits 17 and 18 would also mean that fewer of each or both might be necessary.

EXHIBIT 18

INCINERATOR EQUIVALENTS ESTIMATED TO BE NECESSARY TO HANDLE THE EXCESS DEMAND FOR COMMERCIAL INCINERATION CAPACITY FOR LOHWs UNDER COMBINATIONS OF 4 REGULATORY SCENARIOS



*PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR NEW FACILITIES = 20,000 METRIC TONS.

**PROBABLE FUTURE AVERAGE ANNUAL CAPACITY FOR SHIP = 50,000 METRIC TONS.

APPENDIX A

DEFINITION OF LIQUID ORGANIC HAZARDOUS WASTES

A key input to the incineration market study was determining those wastes that can be included as incinerable or potentially incinerable liquid organic hazardous wastes (LOHWs). Under Task 1 of the Agency's larger incineration study, the Office of Solid Waste (OSW) was responsible for this analysis. Their definition for and list of LOHWs are summarized below.

An incinerable liquid organic hazardous waste was defined by OSW for this study as:

> "Any EPA hazardous wastes that has been reported incinerated as a liquid, and/or, according to the EPA Engineering Handbook for Hazardous Waste Incineration, is suitable for liquid injection incineration."(1)

OSW's source for establishing those wastes "reported to be incinerated" were data from the National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities Regulated Under RCRA in 1981. Respondents to the Survey* were asked to report the waste code, physical form, handling method, and quantities of wastes managed at their facilities in 1981. Potential incinerability was determined solely on the basis of waste rankings (as good, potential, or poor candidates) in the Engineering Handbook.

Applying their definitions, OSW came up with three lists of incinerable LOHWs. These lists are shown in Exhibit A-1 List A represents those wastes labeled in the Engineering Handbook as good or potential candidates for liquid injection

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*Two survey questionnaires provided data on incinerated wastes. The TSD General Questionnaire asked respondents to report data on each of the 10 top waste streams handled at their facility. Those facilities also sent an Incinerator Questionnaire were asked to provide similar and more extensive data for the top five waste streams incinerated.

EXHIBIT A-1
Lists of Liquid Organic Hazardous Wastes Developed By The Office of Solid Waste For The Incineration Market Study

LIQUID ORGANIC HAZARDOUS WASTES

LIST A: GOOD OR POTENTIAL WASTE CODE CANDIDATES FOR LIQUID INJECTION INCINERATION

F001
F002
F003
F004
F005
K015
K023
K047
P002
P003
P005
P020
P022
P028
P039
P041
P042
P063
P068
P069
P081
P089
P094
P097
P102
U002
U003
U004
U008
U009
U012
U019
U023
U031
U037
U041
U044
U046
U051
U053
U056
U057
U066
U069
U070
U074
U076
U077
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U083
U098
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U107
U108
U110
U112
U114
U117
U123
U124
U130
U133
U138
U140
U154
U155
U156
U159
U161
U162
U169
U180
U196
U209
U210
U213
U220
U223
U226
U227
U228
U239
X001[a]
X002
X004
X018
X019
X029
X033
X038
X056
X058
X064
X065
X079
X082
X094
X095
X100
X104
X105
X113
X120
X121
X124
X125
X150
X170
X171
X179

LIST B: SUITABILITY FOR LIQUID INJECTION INCINERATION UNKNOWN

D000
D001
D002
D003
D004
D005
D006
D007
D008
D009
D010
D011
D012
D013
D014
D015
D016
D017
F017
F018
F019
K071
K073
K074
K078
K079
K081
K082
K083
K085
K086
K087
K088
K089
K091
K093
K094
K099
K103
K104
K106
P000
P123
U000
U240
U242
U244
X003
X006
X007
X008
X009
X011
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X021
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X168
X169
X173
X174
X175
X176
X177
X178
X181
X182
X183
X184
X185
X186
X187
X189
X191
X194
Y001
Y002
9995[b]
9998[c]
9999[d]

LIST C: POOR WASTE CODE CANDIDATES FOR LIQUID INJECTION INCINERATION

F006
K001
K016
K018
K036
K052
P033
P074
P095
P106
U043
U122
U134
U177
U188
U189
U192
U201

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a) "X" code wastes are a coding convention developed for the RIA National Survey to designate combinations of EPA waste codes (i.e., mixtures).

b) Survey code for respondents who indicated a waste did not have an EPA waste code.

c) Survey code for respondents who did not know the right EPA waste code.

d) Survey code for responses that could not be ascertained.

incineration. Most, but not all, of these wastes were reported as incinerated in 1981. List B are those wastes OSW determined to be of "less certain incinerability," but could not exclude as potentially incinerable. These wastes include the "D" wastes, wastes containing "D" wastes, and other wastes not characterized by incinerability or incineration technology in the Engineering Handbook. Some of these wastes were reported incinerated as a liquid in 1981. List C wastes were also reported frequently to be incinerated as a liquid in 1981. The Engineering Handbook, however, ranked these wastes as poor candidates for incineration or not suited for liquid injection.

All three lists were considered to constitute the "universe" of LOHWs for purposes of the incineration market study, despite some of the inherent uncertainties. To limit some of the data development necessary for the study, a waste categorization scheme was applied to these lists. This scheme narrowed the analysis down from 294 individual waste codes to 16 waste categories. Exhibit A-2 presents this categorization scheme. This scheme itself is an expanded and modified version of one used by the State of Michigan in "Hazardous Waste Management in Michigan: A Status Report and Review of Future Options."(22)

EXHIBIT A-2
LOHW Waste Code Categorization Scheme Developed for the Incineration Market Study

GROUP	INCLUSIVE LOHW CODES
I. IGNITABLES	D000, D001, X014, X020, X045, X046, X077, X092, X129, X130, X176, X177, X185, X186, X187
II. CORROSIVES	D002, X009, X012, X050, X052, X053, X054, X062, X076, X093, X111, X137, X151, X163, X178, X184
III. REACTIVES	D003
IV. METAL BEARING	D004-D011, X006, X017, X023, X025, X026, X035, X036, X037, X039, X043, X051, X059, X063, X075, X114, X116, X117, X131, X142, X143, X144, X145, X146, X149, X153, X167, X191, X138, X194
V. PESTICIDES	D012-D017, K036, K099, X158
VI. SOLVENTS	F001-F005, X001, X002, X003, X004, X013, X016, X018, X033, X058, X064, X095, X096, X104, X113, X179, X008, X069, X071, X078, X079, X099, X100, X121, X123, X127, X148, X150, X161, X168, X169, X038
VII. ELECTROPLATING	F006, X007, X024, X040
VIII. MISC. PROCESS	F010, K086, K087, K001, X174
IX. INORGANIC PIGMENTS	X087
X. ORGANIC CHEMICALS	K009, K015, K016, K018, K074, K078, K079, K081, K082, K083, K085, K088, K093, K103, K104, X084, X128, X044
XI. EXPLOSIVES	K047, X147, X155
XII. PETROLEUM REFINING	K052
XIII. IRON & STEEL	NONE
XIV. INORGANIC CHEMICALS	K071, K073, K106
XV. MISC. COMMERCIAL CHEMICAL PRODUCTS	P063, P068, P106, U002, U003, U043, U023, U031, U053, U056, U196, U220, U223, U123, U133, U154, U074, U080, U117, U098, P074, U188, U134, U122, X019, X029, X031, X032, X056, X065, X070, X072, X080, X082, X094, X098, X105, X106, X120, X124, X125, X132, X170, X171, X181, X182, X183, X159, X160, X030
XVI. NOT CLASSIFIED	X021, X022, X028, X034, X042, X048, X049, X081, X110, X152, X164, X175, X189, Y001, Y002, 9995, 9998, 9999, X015, X173

APPENDIX B

ESTIMATION OF THE TOTAL QUANTITY OF LOHWs INCINERATED ON-SITE AND OFF-SITE

Once a "universe" of incinerable LOHWs was set, OSW's efforts in their Task 1 study shifted to estimating:

- The total quantity of LOHWs managed by technology
- The percentages of LOHWs managed on-site and off-site by technology.

This proved to be a complicated piece of analysis for the incineration market study. Complications arose in a variety of forms ranging from statistical uncertainties in the data to attempting to define an off-site versus on-site definition, in the context of the RIA National Survey data, suited to the market study. This appendix provides some of the background and analysis behind OSW's data.

1. Quantities of LOHWs Incinerated

Quantities of LOHWs incinerated in 1981 were developed by OSW from responses to the 1981 RIA National Survey. These data are the source of the 0.9 million metric tons (MMT) low-range case baseline estimate cited in Chapter III. Exhibit B-1 presents the quantities of wastes incinerated by LOHW waste code. The amount of liquid incinerated was drawn from responses to the Incinerator Questionnaire. This was an important decision because, as Exhibit B-2 illustrates, quantity incinerated estimates drawn from responses to the TSD General Questionnaire sum to a larger overall quantity (1.3 MMT).

EXHIBIT B-1
Quantities of LOHWs Incinerated in 1981

TOTAL A+B+C = 230,791,000 GAL. (0.86 MMT)[a]

LIST	WASTE CODE	SAMPLE SIZE	AMOUNT LIQUID INCINERATED (10^3 GAL)
A	F001	1	9
	F002	6	1,614
	F003	22	24,227
	F005	20	17,665
	K015	1	153
	P063	5	62
	P068	1	40
	U002	5	518
	U003	2	2,438
	U023	1	253
	U031	1	96
	U044	1	1
	U053	1	25
	U056	2	108
	U074	1	738
	U080	3	2
	U098	1	2
	U117	2	2
	U123	1	1
	U133	1	24
	U154	7	80
	U196	1	1
	U220	4	1
	U223	1	48
	X001	1	6
	X002	1	144
	X124	1	1
	X179	1	6
			48,262 (0.18 MMT)[a]
B	D000	1	5,151
	D001	59	61,154
	D002	9	2,860
	D003	9	3,488
	K083	2	528
	K085	1	396
	K093	1	178
	X013	2	655
	X015	2	1,491
	X028	2	359
	X042	1	6,246
	X072	1	710
	X110	1	642
	X175	1	432
	X182	1	80,864
	9995	13	12,455
			177,609 (0.66 MMT)[a]

EXHIBIT B-1 (Continued)

LIST	WASTE CODE	SAMPLE SIZE	AMOUNT LIQUID INCINERATED (10^3 GAL)
C	K001	1	18
	K016	1	983
	K018	1	1,542
	K036	1	81
	P074	1	235
	P106	1	1
	U043	3	656
	U122	6	246
	U188	5	1,158
			4,920 (0.018 MMT)[a]

a) Assumes 268.8519 gallons per metric ton.

SOURCE: (1)

EXHIBIT B-2

Variations in Estimated Quantities of LOHWs Incinerated in 1981

LOHW Category	Incinerator Questionnaire As Data Source 7/84[a] Total Incinerated Quantity (Gallons)	Percent of Total	Incinerator Questionnaire As Data Source 5/84 & 7/84[b] Total Incinerated Quantity (Gallons)	Percent of Total	TSD General Questionnaire As Data Source 7/84[c] Total Incinerated Quantity (Gallons)	Percent of Total
IGNITABLES	56,061,954	25.9	66,305,000	28.7	49,829,360	14.2
CORROSIVES	4,585,490	2.1	2,860,000	1.2	5,011,298	1.4
REACTIVES	3,849,897	1.8	3,488,000	1.5	3,713,934	1.1
METAL BEARING	177,734	0.08	-	-	203,480	0.06
PESTICIDES	81,111	0.04	81,000	0.04	178,781	0.05
SOLVENTS	32,146,219	14.9	44,323,000	19.2	72,992,913	20.7
ELECTROPLATING	-	-	-	-	-	-
MISC. PROCESS	51,385	0.02	18,000	0.01	34,266	0.01
INORGANIC PIGMENTS	-	-	-	-	-	-
ORGANIC CHEMICALS	3,507,380	1.6	3,780,000	1.6	2,915,454	0.8
EXPLOSIVES	-	-	-	-	39,884	0.01
PETROLEUM REFINING	62,799	0.03	-	-	8,144,221	2.3
IRON & STEEL	-	-	-	-	-	-
INORGANIC CHEMICALS	-	-	-	-	-	-
MISC. COMMERCIAL CHEMICAL PRODUCTS	88,686,950	41.0	88,311,000	38.3	200,595,158	57.0
OTHER	27,066,001	12.5	21,625,000	9.3	8,348,141	2.4
	216,276,920 (0.82 MMT)		230,791,000 (0.87 MMT)		352,006,890 (1.33 MMT)	

[a] Computer run provided through OSW, 7/30/84.
[b] OSW data in draft and final Task 1 report.
[c] Computer run provided through OSW, 7/25/84.

Quantities incinerated in 1981 were based on the Incinerator Questionnaire rather than the TSD General Questionnaire for four reasons:

- The Incinerator Questionnaire asks for a direct estimate of liquids incinerated
- Responses to the Incinerator Questionnaire appear to be more consistent on the quantity of wastes incinerated relative to other data for those facilities who also responded to the TSD General Questionnaire
- None of the Incinerator Questionnaire-derived quantities had to be imputed whereas about 20 percent of the TSD General Questionnaire-derived data had to be imputed (i.e., insufficient data provided)
- Wastewater in tanks was erroneously included as incinerated waste at one facility responding to the TSD General Questionnaire leading to an overestimate of 196 million gallons (0.7 MMT).

While OSW considered the Incinerator Questionnaire to be the better source of data, they caution that, even so, the statistical reliability of these data is poor due to small sample sizes. In fact, these sample sizes (shown in Exhibit B-1) are smaller than the TSD facility sample that yielded confidence intervals of roughly 50 percent at the 95 percent confidence level.

This statistically-based caution applies to all uses of the RIA National Survey data in the market analysis. Questionable statistical reliability was cited, for example, in OSW's decision to advise against using the RIA National Survey data to develop regional waste generation and management estimates. OSW also questions the validity of using these data to develop on-site and off-site (noncommercial v. commercial) splits on the same grounds. OSW's concerns and cautions are statistically sound and valid. At the same time, the RIA National Survey data are the "best" available usable for an analysis of the incineration market. Therefore, while these data have been used and interpreted beyond statistically valid limits, their use to suggest possible outcomes seems appropriate. As more and better data become available, the market analysis can be adjusted.

2. Quantities of Wastes Managed By Other Technologies

OSW provided national-level estimates of all wastes and LOHWs managed by all other, non-thermal technologies. These data are drawn from TSD General Questionnaire responses. While some of these technologies were also covered in specific questionnaires (like the Incinerator Questionnaire), OSW elected not to utilize these other data.

Exhibit B-3 summarizes the data provided by OSW and compares it with the estimates cited in the report on the 1981 National Survey results. This comparison points out two other problems in interpreting these data correctly: double-counting and imputations. Wastes frequently are subject to multiple processing at a facility. This means that they can be counted several times when a respondent provides a figure for the total quantity of wastes managed. This is one reason that the by-technology totals exceed the estimated total of 71.3 billion gallons (264 MMT) of wastes managed in 1981. The by-technology totals differ between the two sources as OSW imputed national totals from its survey sample and imputed data for non-respondents when developing its 1981 National Survey report. However, much of the data provided by OSW for this study reflects the "as responded" totals drawn from the RIA National Survey data base without the national weights, imputations, and other adjustments.

EXHIBIT B-3
Total Wastes and LOHWs Managed By Management Technology

Technology	Quantity of Hazardous Wastes Managed[a] (10^9 Gal)	Quantity of Hazardous Wastes Managed[b] (10^9 Gal)	Quantity of LOHWs Managed[b] (10^9 Gal)
Treatment Tanks	8.7	15.5	N.E.
Treatment Impoundments	16.6	11.0	11.1
Incineration	0.5	0.4	0.2
Other Treatment	4.6	-	N.E.
Total Treated:	30.4 (47.5)	26.9	
Injection Well	8.6	51.8	51.9
Landfill	0.8	0.9	0.9
Land Application	0.1	0.1	N.E.
Disposal Impoundments	5.1	4.0	4.0
Other Disposal	0.2	-	N.E
Total Disposed:	14.8 (14.7)	56.8	
Storage Impoundments	14.1	10.7	10.7
Storage Tanks	5.1	4.0	N.E.
Storage Containers	0.2	0.1	N.E.
Waste Piles	0.4	0.2	N.E.
Other Storage	0.3	-	N.E.
Total Stored:	20.1 (36.5)	15.0	
	65.3 (98.7)	98.7	
vs. Total Wastes Managed[a]	71.3		

a. Data taken from 1981 National Survey Report. Numbers in parentheses are reported technology group totals.

b. Technology totals from 1981 National Survey data base for TSDs reporting the percentage of wastes received from off-site.

N.E. = Not estimated.

3. On-Site and Off-Site Splits of LOHWs Managed By Technology

An initial calculation in nearly every scenario analysis is determining the quantity of wastes managed, by technology, at noncommercial and commercial facilities. These on-site versus off-site splits* become important later in each analysis as each regulatory change is assumed to bring about a shift between managing wastes on-site and off-site. This shift would supposedly reflect a generator's decision to no longer manage some or all of its own wastes, preferring to send these wastes off-site to a commercial facility, or, alternatively, a decision to manage more of its own wastes rather than sending wastes off-site.

This part of the Task 1 data analysis focused on adapting the RIA National Survey data to the market analysis definition of a commercial facility to establish on-site/off-site splits for all wastes and LOHWs managed by technology. A commercial facility, for purposes of the market analysis, is defined as privately owned and operated receiving most of its wastes from off-site and other firms.** The on-site/off-site split is determined, therefore, by setting a threshold, that varies by technology, where the National Survey data show that most of the wastes managed by reporting facilities came from off-site, and where most of these off-site-origin wastes came from other firms.

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*For purposes of this study, the terms "on-site" and off-site" are equated to the terms "noncommercial" and "commercial," respectively. See Appendix E for definitions of these terms.

**This definition differs slightly from the one used in the RIA National Survey report. The key distinction is a commercial facility is defined in the survey report as one that receives 50 percent or more of its waste from other firms without reference to the on-site or off-site origin of the waste. This is intended to allow for some generation of wastes on-site at the commercial facility and for intrafirm shipments between commercial facilities under the same ownership. The definition used in the market analysis, while allowing for these exceptions, emphasizes that most of commercial facility's business is in the form of other firm's wastes sent from off-site.

Unfortunately, Exhibit B-4 shows that establishing the on-site/off-site split on the basis of this definition of a commercial facility is not simple. It was expected that as the percentage of wastes received from off-site increased that the portion of these off-site wastes originating from other firms would also increase. This trend can be seen, but it is not consistent. The clearest exception can be seen at the 100 percent from off-site level. Of this total, 80 percent represents shipments between a generator and its own captive (i.e., noncommercial) facility that should not be counted as commercial activity. Exhibit B-5 shows that this lack of consistency also appears in attempting to determine on-site versus off-site splits, for all wastes managed, by technology.

Nevertheless, some delineation between quantities of wastes managed on-site versus off-site needs to be made to perform the market analysis. As such, "commercial thresholds" were set based upon the relationship of the percentage of wastes received from off-site with the percentages of off-site wastes received from the same and other firms. Referring to Exhibit B-5, for example, these thresholds were set at 60 percent, 10 percent, and 70 percent wastes received from off-site for all wastes incinerated, landfilled, and injected, respectively. These thresholds appear to be reasonable matches to the market analysis commercial definition.

These "commercial" thresholds establish how much waste is managed on-site (i.e., at noncommercial facilities) versus off-site (i.e., at commercial facilities) by technology. The cumulative percentage of wastes managed up to the threshold is equated to the percentage of wastes managed on-site; the remaining percentage becomes the percentage of wastes managed off-site. As summarized in Exhibit B-6, these on-site/off-site splits by technology for all wastes derived from the RIA National Survey data base are:

EXHIBIT B-4

Definition of Commercial Activity: Percent of All Wastes Received By TSDs from Off-Site Either Same-Firm or Other-Firm Origin - 1981 RIA National Survey

Percent of Total Wastes Managed Received From Off-Site	Cumulative Percent Of Total Wastes Managed	Same-Firm Origin Wastes - Percent of Off-Site Total	Other-Firm Origin Wastes Percent of Off-Site Total
0	82.4	-	-
5	89.9	100	0
10	90.2	0	100
15	90.2	99.4	0.6
25	90.7	58.1	41.9
30	90.7	100	0
40	90.7	0	100
55	90.7	0	100
75	91.0	0	100
90	91.0	100	0
95	91.1	0	100
100	100.0	81.1	18.9

Total Quantity of Wastes Managed (10^9 Gal)	Total Quantity of Wastes On-Site Origin (10^9 Gal)	Total Quantity of Wastes Off-Site Origin (10^9 Gal)	Quantity of Off-Site Wastes	
			Same-Firm Origin (10^9 Gal)	Other-Firm Origin (10^9 Gal)
60.1[a]	54.6	5.5	4.3[b]	1.2[c]
Percent of all wastes managed:	90.8	9.2	7.2	2.0
Percent of Off-Site-origin wastes:	-	-	78.2	21.8

[a] Sum of all wastes managed by TSDs reporting what percent of their wastes was received from off-site.

[b] Of this total, 4.2 billion gallons were same-firm wastes received by TSDs reporting that 100 percent of the wastes managed were off-site-origin wastes. Further examination showed that 96 percent of this amount was indeed shipments between generators and captive TSDs (i.e., intrafirm shipments).

[c] Amount reflects preferred definition of "true" off-site commercial activity.

EXHIBIT B-5

Defining a "Commercial" Threshold: On-Site and Off-Site Splits of All Wastes Managed By Technology

Percent of Wastes Managed From Off-site	INCINERATION Quantity of Wastes Managed (10^9 Gal)				LANDFILL Quantity of Wastes Managed (10^9 Gal)				INJECTION WELL Quantity of Wastes Managed (10^9 Gal)			
		Cumulative % of Wastes Managed	% of Total Offsite-Origin Wastes Received From Same Firm	% of Total Offsite-Origin Wastes Received From Other Firm		Cumulative % of Wastes Managed	% of Total Offsite-Origin Wastes Received From Same Firm	% of Total Offsite-Origin Wastes Received From Other Firm		Cumulative % of Wastes Managed	% of Total Offsite-Origin Wastes Received From Same Firm	% of Total Offsite-Origin Wastes Received From Other Firm
0	324,513,963	91.1	0	0	54,111,337	6.1	0	0	51,427,081,724	99.2	0	0
1	3,006,140	91.9	8.3	91.7	325,766,562	42.6	11.1	88.9	35,666,228	99.3	6.7	93.3
2	4,230,895	93.1	100	0								
3	7,081,554	95.1	95.6	4.4								
4	140,151	95.1	100	0								
6					1,970,981	42.8	100	0				
7	6,178,881	96.8	100	0								
8									24,939,175	99.3	100	0
10					- - - - - -		COMMERCIAL THRESHOLD - - - - - - -					
13	119,439	96.8	96	4								
18									264,217,528	98.8	92	8
25	4,178,258	98.0	58	42								
33	14,232	98.0	100	0								
54	- - - - - -		COMMERCIAL THRESHOLD - - - - - - -		15,979,206	44.6	0	100				
62					1,960,904	44.8	0	100				
64	2,074,907	98.6	0	100								
67	1,033,845	98.9	34	66					- - - - - - - -	COMMERCIAL THRESHOLD - - - - - - - - -		
73					30,971,963	48.3	0	100				
74												
86					24,199,293	51.0	0	100				
90	37,076	98.9	100	0								
97	42,740	98.9	100	0	4,711,704	51.5	5	95				
99	512,579	99.1	0	100								
100	3,133,076	100.0	0.1	99.9	433,791,604	100.0	6.3	93.7	81,598,602	100	3.7	96.3

@ ≥60% threshold: 98% on-site, 2% off-site

@ ≥10% threshold: 43% on-site 57% off-site

@ ≥70% threshold: 99.8% on-site, 0.2% off-site

EXHIBIT B-6
On-Site v. Off-Site National Splits By Technology For All Wastes - 1981 National Survey Data

Technology	Percent Offsite-Origin Used to Define "Commercial"[a]	Percent Of All Wastes Managed[b]							
		National Survey Estimates		Market Analysis Estimates					
		On-Site[c]	Off-Site[c]	Low-Range Case[d]		Mid-Range Case[d]		High-Range Case[d]	
				On-Site	Off-Site	On-Site	Off-Site	On-Site	Off-Site
Incineration	60	93	7	90.0[e]	10.0[e]	90.0[e]	10.0	90.0[e]	10.0[e]
Injection Well	70	98.8	1.2	97.5	2.5	97.5	2.5	97.5	2.5
Landfill	10	42.8	57.2	43	57	30	70	16	84
Disposal Impoundments	70	96.8	3.2	95	5	95	5	95	5

a) Derived from the distribution of percent offsite-origin wastes received by technology and the percentages of same-firm v. other-firm origin for offsite wastes managed (see also Exhibits B-4 and B-5). Commercial thresholds set at the point where most wastes were received from off-site and other firms.

b) Determined from cumulative percentage of wastes managed up to commercial threshold (see also Exhibit B-5).

c) Are derived from application of commercial threshold to RIA National Survey data. RIA National Survey report does not make an off-site v. on-site distinction. (See also Appendix E; on-site = noncommercial, off-site = commercial).

d) Represent three cases as part of sensitivity analysis of demand for incineration. Reflect variability in key estimates/assumptions over a lowest to highest possible number range (see also Chapters III, IV, and VI and Appendices C and D).

e) Are on-site v. off-site splits assumed as applied to liquid organic hazardous wastes only.

- Incineration - 93 percent on-site, 7 percent off-site
- Injection wells - 98.8 percent on-site, 1.2 percent off-site
- Landfills - 43 percent on-site, 57 percent off-site
- Disposal impoundments - 96.8 percent on-site, 3.2 percent off-site.

This exhibit also compares the Survey-derived splits with the splits assumed in each of the low-range, mid-range, and high-range regulatory scenarios. For three technologies--incineration, injection wells, and disposal impoundments--the Survey-derived on-site/off-site distributions compare favorably with the distributions assumed in the market analysis scenarios. Lacking any other available estimates, therefore, these assumed splits were used across all three sensitivity analyses* of the projected demand for commercial incineration capacity. Only the landfill restrictions scenario analysis involved varying the on-site/off-site distribution as part of the sensitivity analysis. This variation reflects a difference in estimates of this distribution for landfills across available sources. The Survey-derived distribution of 43 percent on-site and 57 percent off-site for landfilled wastes is one of these estimates, and has been used as part of the low-range case in the sensitivity analysis. Alternatively, a comparison of the National Survey's estimate of 3.2 million metric tons of wastes landfilled in 1981 with an estimate of wastes landfilled at commercial facilities in 1980 (2.7

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* A sensitivity analysis was made part of the market analysis given the variability and uncertainties in key estimates and assumptions like the on-site/off-site distribution by technology. Chapters I, II, and IV describe in more detail how the sensitivity analysis has been constructed; however, the basic the basic features are a low-range, mid-range, and high-range case built from the range of possible values for certain estimates and assumptions as suggested by the available sources.

million metric tons) drawn from commercial hazardous waste management industry surveys, indicates that the distribution may be as high as 16 percent on-site and 84 percent off-site. This alternative distribution has also been incorporated into the sensitivity analysis as a high-range estimates case.

Exhibits B-7 and B-8 present some background data behind the on-site/off-site distributions by technology shown in Exhibit B-6. Exhibit B-7, in particular, shows the weighted averages for the on-site/off-site splits by technology for all wastes. These averages are those presented in Exhibit B-6. For comparison, Exhibit B-8 offers similar data, but only for LOHWs. The weighted on-site/off-site splits by technology for only LOHWs are also reasonably consistent with the market analysis assumptions though some differences are evident.

EXHIBIT B-7

On-Site v. Off-Site National Splits by Technology For All Wastes - 1981 National Survey Data

WASTE CATEGORY	INCINERATION				LANDFILL				INJECTION WELL				DISPOSAL IMPOUNDMENTS				TOTAL QUANTITY MANAGED BY CATEGORY	% OF ALL WASTES MANAGED
	QUANTITY MANAGED[a] (GAL)	% OF ALL WASTES MANAGED	% MANAGED ONSITE[b]	% MANAGED OFFSITE[b]	QUANTITY MANAGED (GAL)	% OF ALL WASTES MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE	QUANTITY MANAGED (GAL)	% OF ALL WASTES MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE	QUANTITY MANAGED (GAL)	% OF ALL WASTES MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE		
IGNITABLES	56,061,954	25.9	93	7	15,966,963	1.8	20	80	25,935,972	0.4	19	81	5,312,309	0.1	0.2	99.8	103,277,198	0.9
CORROSIVES	4,585,490	2.1	94	6	70,655,512	7.9	13	87	3,011,690,259	44.2	99.8	0.2	192,720,506	4.7	90	10	3,279,651,767	27.5
REACTIVES	3,849,897	1.8	98	2	2,906,346	0.3	40	60	614,848,112	9.0	96	4	597,214	0.01	100	0	622,201,569	5.2
METAL BEARING	177,734	0.08	100	0	151,278,330	16.9	10	90	541,629,110	8.0	98	2	152,074,247	3.7	70	30	845,159,421	7.1
PESTICIDES	81,111	0.04	100	0	3,740,239	0.4	0	100	-	-	-	-	-	-	-	-	3,821,350	0.03
SOLVENTS	32,146,219	14.9	95	5	27,186,450	3.0	0.1	99.9	290,641,973	4.3	99.8	0.2	7,028,198	0.2	100	0	357,002,840	3.0
ELECTROPLATING	-	-	-	-	55,539,725	6.2	11	89	438,489	0.01	0	100	16,406,928	0.4	96	4	72,385,192	0.6
MISC. PROCESS	51,385	0.02	35	65	6,383,500	0.7	0.3	99.7	-	-	-	-	3,832,877	0.1	100	0	10,267,762	0.09
INORGANIC PIGMENTS	-	-	-	-	3,802,502	0.4	0	100	-	-	-	-	-	-	-	-	3,802,502	0.03
ORGANIC CHEMICALS	3,507,380	1.6	100	0	12,454,970	1.4	86	14	991,590,521	14.6	99.8	0.2	1,066,333	0.03	0	100	1,008,619,204	8.5
EXPLOSIVES	-	-	-	-	85,594	0.01	100	0	-	-	-	-	5,555,434	0.1	100	0	5,641,028	0.05
PETROLEUM REFINING	62,799	0.03	0	100	33,769,670	3.0	0.4	99.6	-	-	-	-	3,500,000,000	87.3	100[d]	0	3,533,832,469	29.6
IRON & STEEL	-	-	-	-	158,119,821	17.6	10	90	22,635,650	0.3	80	20	50,912,702	1.3	5	95	231,668,173	1.9
INORGANIC CHEMICALS	-	-	-	-	5,906,395	0.7	77	23	-	-	-	-	1,057,379	0.03	100	0	6,963,774	0.06
MISC. CHEM. PRODUCTS	88,686,950	41	98	2	312,788,720	34.9	96	4	350,705,316	5.1	99.8	0.2	73,406,704	1.8	100	0	825,587,690	6.9
OTHER	27,066,001	12.5	75	25	35,425,271	3.9	45	55	960,366,560	14.1	99.5	0.5	2,060,868	0.05	41	59	1,024,918,700	8.6
TOTAL	216,276,920				896,010,008				6,810,481,962				4,012,031,699				11,934,801,000	
WEIGHTED AVERAGES:[c]			93	7			43	57			98.8	1.2			96.8	3.2		

a. For all TSDs reporting what percent of their wastes were received from off-site.

b. Calculated by applying commercial thresholds for all wastes.

c. Weighted by categories' percentages of all wastes managed.

d. In the RIA data base, this quantity of wastes is actually indicated to be 100 percent from off-site. Further examination of this large quantity, however, indicated that these wastes were actually same-firm origin wastes that should be classed as noncommercial (i.e., on-site).

EXHIBIT B-8

On-Site v. Off-Site National Splits by Technology And LOHW Category - 1981 National Survey Data

LOHW CATEGORY	INCINERATION				LANDFILL				INJECTION WELL				DISPOSAL IMPOUNDMENTS				TOTAL QUANTITY MANAGED BY CATEGORY	% OF ALL LOHWs MANAGED
	QUANTITY MANAGED[a] (GAL)	% OF ALL LOHWs MANAGED	% MANAGED ONSITE[b]	% MANAGED OFFSITE[b]	QUANTITY MANAGED (GAL)	% OF ALL LOHWs MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE	QUANTITY MANAGED (GAL)	% OF ALL LOHWs MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE	QUANTITY MANAGED (GAL)	% OF ALL LOHWs MANAGED	% MANAGED ONSITE	% MANAGED OFFSITE		
IGNITABLES	56,061,954	25.9	93	7	12,689,103	1.8	20	80	25,936,008	0.5	19	81	5,312,309	1.2	0.2	99.8	99,999,374	1.4
CORROSIVES	4,585,490	2.1	94	6	70,655,629	10.2	13	87	2,963,663,191	52.4	99.8	0.2	192,720,506	42.2	90	10	3,231,624,816	46.0
REACTIVES	3,849,897	1.8	98	2	2,906,349	0.4	40	60	614,052,596	10.9	96	4	597,214	0.1	100	0	621,406,056	8.8
METAL BEARING	177,734	0.08	100	0	147,441,643	21.3	10	90	540,353,621	9.6	98	2	152,074,247	33.3	70	30	840,047,245	12.0
PESTICIDES	81,111	0.04	100	0	759,274	0.1	0	100	-	-	-	-	-	-	-	-	840,385	0.01
SOLVENTS	32,146,219	14.9	95	5	27,186,504	3.9	0.1	99.9	291,804,238	5.2	99.8	0.2	7,028,201	1.5	100	0	358,165,162	5.1
ELECTROPLATING	-	-	-	-	52,829,235	7.6	11	89	-	-	-	-	16,406,928	3.6	96	4	69,236,163	1.0
MISC. PROCESS	51,385	0.02	35	65	4,279,159	0.6	0.3	99.7	-	-	-	-	3,832,877	0.8	100	0	8,163,421	0.1
INORGANIC PIGMENTS	-	-	-	-	3,802,503	0.5	0	100	-	-	-	-	-	-	-	-	3,802,503	0.05
ORGANIC CHEMICALS	3,507,380	1.6	100	0	11,242,229	1.6	86	14	-	-	-	-	1,066,333	0.2	0	100	15,815,942	0.2
EXPLOSIVES	-	-	-	-	-	-	-	-	-	-	-	-	460,172	0.1	100	0	460,172	0.01
PETROLEUM REFINING	62,799	0.03	0	100	10,277,575	1.5	0.4	99.6	-	-	-	-	621,241	0.1	100	0	10,961,615	0.2
IRON & STEEL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INORGANIC CHEMICALS	-	-	-	-	5,906,399	0.9	77	23	-	-	-	-	1,057,379	0.2	100	0	6,963,778	0.1
MISC. CHEM. PRODUCTS	88,686,950	41	98	2	307,292,033	44.4	96	4	261,479,526	4.6	99.8	0.2	73,253,475	16.0	100	0	730,711,984	10.4
OTHER	27,066,001	12.5	75	25	35,425,271	5.1	45	55	960,366,560	17.0	99.5	0.5	2,060,868	0.5	41	59	1,024,918,700	14.6
TOTAL	216,276,920				692,692,906				5,657,655,740				456,491,750				7,023,117,316	
WEIGHTED AVERAGES:[c]			93	7			52	48			98.9	1.1			84	16		

a. For all TSDs reporting what percent of their wastes were received from off-site.

b. Calculated by applying commercial thresholds for all wastes to LOHW quantities.

c. Weighted by categories' percentages of all LOHWS managed.

APPENDIX C

MARKET ANALYSIS MODULES: LOGIC DIAGRAMS FOR BASELINE MARKET CONDITIONS AND REGULATORY SCENARIO ANALYSES--MID-RANGE ESTIMATES CASE

The following logic diagrams trace the key data and assumptions for the mid-range estimates case for the baseline incineration capacity utilization module, and each of the regulatory scenario modules that estimate the demand for incineration after RCRA regulatory change. Preceding each module is a brief description of its objectives and results. Sources of the data and assumptions used are referenced.

The more critical assumption in each analysis are highlighted within dotted-line boxes in the logic flow. Variations in these assumptions are perceived to have the greatest effect on the projected outcomes. Appendix E incorporates these variations in describing the low-range and high-range estimates cases that are part of the sensitivity analysis for each module. All three cases--the low-range, mid-range, and high-range--are built from the range of estimates suggested by the sources consulted for the key data and assumptions. The sensitivity analysis results are discussed in Chapter III, IV, and VI.

Nine mid-range case modules are presented. These nine include logic diagrams on:

- Baseline LOHW incineration capacity utilization
  - LOHW volumes incinerated on-site and off-site*
  - LOHW on-site and off-site incineration capacity

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* As used here, reference to on-site and off-site should be interpreted as noncommercial and commercial, respectively. See Appendix F for complete definitions of key terms in the market study.

- Incineration capacity utilization for PCBs
    - PCB volumes incinerated (use phaseout, failures, carryover volumes)
    - PCB liquids incineration capacity
- Effects of restrictions on landfills
    - Wastes landfilled on-site and off-site affected by restrictions
    - Demand for present incineration capacity after restrictions
- Effects of deep well injection restrictions
    - Wastes injected in on-site and off-site wells
    - Demand for present incineration capacity after restrictions
- Effects of disposal impoundment restrictions
    - Wastes disposed in on-site and off-site disposal impoundments
    - Demand for present incineration capacity after restrictions

- Effects of restrictions on wastes-in-boilers

  - Hazardous wastes burned in boilers

  - Demand for present incineration capacity after restrictions

- Addition of incineration-at-sea capacity

  - Capacities of individual incinerator ships

  - Availability of total land-based and at-sea incineration capacity

- Effects of Superfund clean-up activity on RCRA capacity

  - Data needs and sources
  - Data analysis

- Organic liquids likely to be listed as hazardous wastes

  - Total estimated volume of organic liquids
  - Volumes handled by current management methods.

Note that each regulatory scenario analysis module estimates the demand for on-site and off-site LOHW incineration capacity under static supply conditions, that is, available capacity is held fixed for this instantaneous analysis at the practical maximum commercial LOHW incineration capacity level of 300,000 metric tons (minus 48,000 metric tons of capacity for liquids PCBs) and 3.1 MMT of noncommercial LOHW incineration capacity. Refer to Chapters II, III, and V for discussions of available capacity and projected increases in capacity.

BASELINE LOHW INCINERATION CAPACITY UTILIZATION: MID-RANGE ESTIMATES CASE

OBJECTIVE:	To estimate baseline LOHW incineration capacity utilization by: . Estimating baseline quantities of LOHWs incinerated on-site and off-site . Estimating total on-site and off-site LOHW incineration capacity
RESULTS:	On-site baseline incineration capacity utilization = 40.4% Off-site baseline incineration capacity utilization = 55.3% Net off-site LOHW incineration capacity = 0.252 MMT
KEY DATA:	Total quantity of LOHWs incinerated = 1.39 MMT Total quantity of LOHWs incinerated on-site = 1.253 MMT Total quantity of LOHWs incinerated off-site = 0.139 MMT Total off-site LOHW incineration capacity = 0.30 MMT Incineration capacity for PCBs = 0.048 MMT

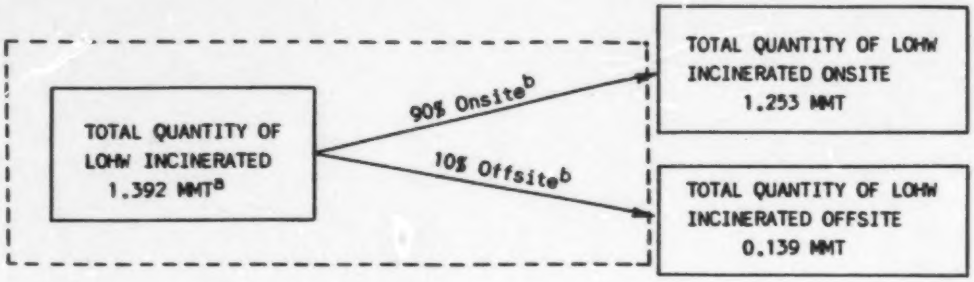
KEY ASSUMPTIONS: 90% of total LOHWs incinerated are incinerated on-site; 10% off-site

Total LOHW incinerated capacity = 3.4 MMT

91.2% of total LOHW incineration capacity is on-site; 8.8% is off-site

LOHW INCINERATION
BASELINE CAPACITY UTILIZATION: MID-RANGE ESTIMATES CASE

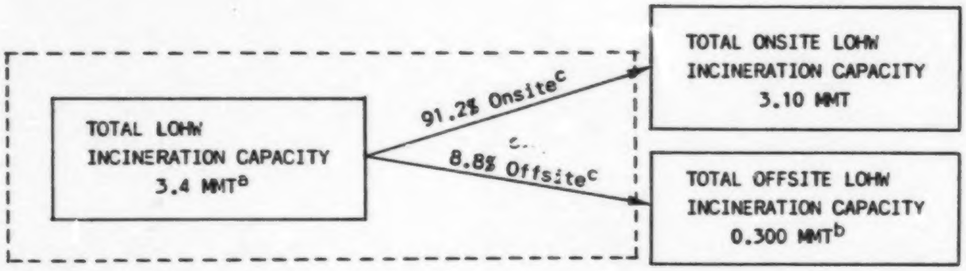
INCINERATED LOHW VOLUMES

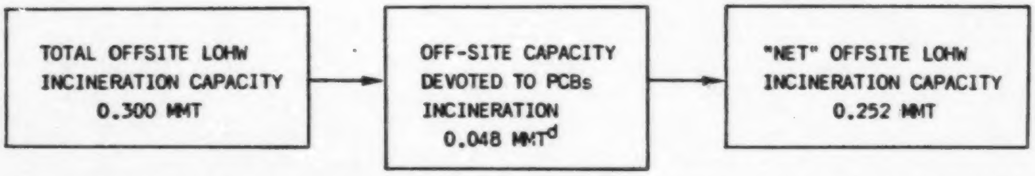

TOTAL QUANTITY OF
LOHW INCINERATED
1.392 MMT[a]
90% Onsite[b]
10% Offsite[b]
TOTAL QUANTITY OF LOHW
INCINERATED ONSITE
1.253 MMT
TOTAL QUANTITY OF LOHW
INCINERATED OFFSITE
0.139 MMT

a) Estimate based upon range of estimates for commercial incineration capacity utilization. Range suggested is from about 40 percent (low-range case) to about 80 percent (high-range case) making mid-range case ≈60 percent. At 0.252 million metric tons of net commercial incineration capacity, 60 percent capacity utilization, and 10 percent of total LOHWs incinerated at commercial facilities, gives mid-range baseline demand shown.

b) Suggested by industry sources and analysis of RIA National Survey data (see Appendix C).

LOHW INCINERATION CAPACITY


TOTAL LOHW
INCINERATION CAPACITY
3.4 MMT[a]
91.2% Onsite[c]
8.8% Offsite[c]
TOTAL ONSITE LOHW
INCINERATION CAPACITY
3.10 MMT
TOTAL OFFSITE LOHW
INCINERATION CAPACITY
0.300 MMT[b]


TOTAL OFFSITE LOHW
INCINERATION CAPACITY
0.300 MMT
OFF-SITE CAPACITY
DEVOTED TO PCBs
INCINERATION
0.048 MMT[d]
"NET" OFFSITE LOHW
INCINERATION CAPACITY
0.252 MMT

a) Estimate based upon modified assumptions to Mitre's calculation, p.2-10 through 2-12 in the Interim Incineration RIA: 209 facilities x 595.4 gal/hr x 7200 hr/yr x 0.00378 gal/metric ton = 3.4 million metric tons. 7200 hr/yr derived from industry sources.

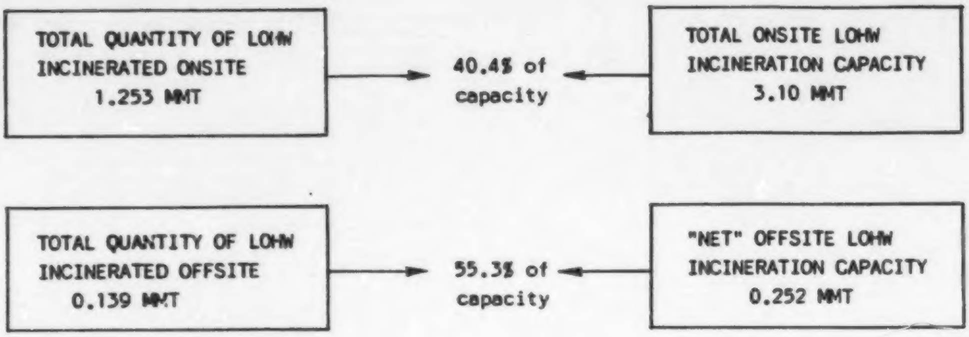
b) Estimate derived from contacts with commercial incineration firms.

c) Relationship established by 0.3 MMT÷3.4 MMT.

d) See PCB module.

LOHW INCINERATION
BASELINE CAPACITY UTILIZATION: MID-RANGE ESTIMATES CASE (CONT'D)

CAPACITY UTILIZATION ESTIMATE


TOTAL QUANTITY OF LOHW INCINERATED ONSITE 1.253 MMT
40.4% of capacity
TOTAL ONSITE LOHW INCINERATION CAPACITY 3.10 MMT
TOTAL QUANTITY OF LOHW INCINERATED OFFSITE 0.139 MMT
55.3% of capacity
"NET" OFFSITE LOHW INCINERATION CAPACITY 0.252 MMT

PREFACE TO PCB MODULE

This module was developed principally to estimate commercial incineration capacity for liquid PCBs so that this capacity could be subtracted out from commercial capacity for all LOHWs. Estimates of the demand for liquid PCB incineration capacity are presented solely to make this module similar to the others in this appendix. In fact, part of the demand analysis is determined by the estimate for capacity.

Industry sources and EPA staff were consulted on estimating commercial incineration capacity for liquid PCBs. The data for capacity shown in the module were provided by EPA staff in May 1984, and reflect permit limits established at that time. According to industry sources, these permit limits have since changed or soon will change, and must be interpreted carefully as their phrasing often determines the maximum throughput of PCBs (and their form) alone and/or the throughput of PCB-contaminated materials. In the module, capacity expressed as metric tons of PCBs per year has been equated to metric tons of PCB-contaminated material per year. In actuality, PCBs probably account for 15-20 percent of the total voume throughput.

INCINERATION CAPACITY UTILIZATION FOR PCBs*

OBJECTIVE: To estimate net incineration capacity for non-PCB LOHWs by:

- Estimating total volumes of liquid PCBs incinerated
- Estimating total incineration capacity for PCBs

RESULTS: Total volume of PCBs incinerated = 0.048 MMT
Total incineration capacity for PCBs = 0.048 MMT
Net incineration capacity for non-PCB LOHWs = 0.252 MMT

KEY DATA: Total volume of PCBs to be incinerated from PCB capacitors and askarel = 8.9 million gallons

- 3.2 million gallons form use phaseout of PCB capacitors and askarel transformers
- 4.1 million gallons from removal of mineral oil transformers
- 1.6 million gallons from storage

Total incineration capacity for PCB = 0.048 MMT

KEY ASSUMPTIONS: Incineration capacity utilization for PCBs is at 100 percent.

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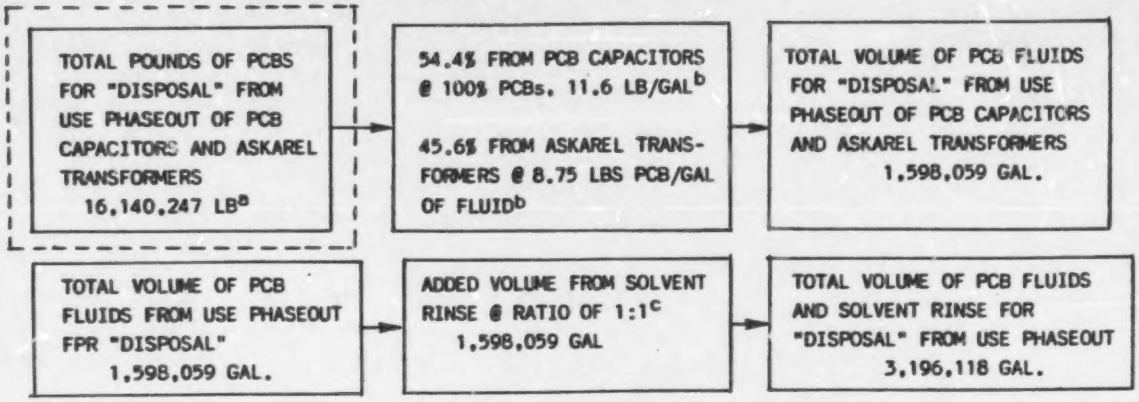
* Does not vary across mid-range, low-range, and high-range estimates cases.

INCINERATION CAPACITY UTILIZATION
PCB VOLUMES INCINERATED AND INCINERATION CAPACITY

TOTAL PCB VOLUMES - USE PHASE OUT - CAPACITORS/ASKAREL TRANSFORMERS

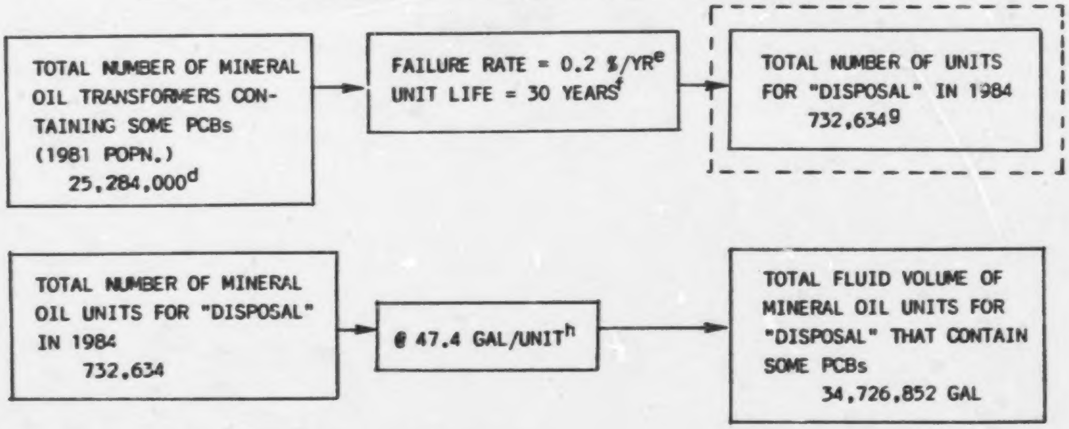

TOTAL POUNDS OF PCBS FOR "DISPOSAL" FROM USE PHASEOUT OF PCB CAPACITORS AND ASKAREL TRANSFORMERS 16,140,247 LB[a]
54.4% FROM PCB CAPACITORS @ 100% PCBs, 11.6 LB/GAL[b]
45.6% FROM ASKAREL TRANSFORMERS @ 8.75 LBS PCB/GAL OF FLUID[b]
TOTAL VOLUME OF PCB FLUIDS FOR "DISPOSAL" FROM USE PHASEOUT OF PCB CAPACITORS AND ASKAREL TRANSFORMERS 1,598,059 GAL.
TOTAL VOLUME OF PCB FLUIDS FROM USE PHASEOUT FPR "DISPOSAL" 1,598,059 GAL.
ADDED VOLUME FROM SOLVENT RINSE @ RATIO OF 1:1[c] 1,598,059 GAL
TOTAL VOLUME OF PCB FLUIDS AND SOLVENT RINSE FOR "DISPOSAL" FROM USE PHASEOUT 3,196,118 GAL.

a) Figure for 1984 from Table 46, July 1982 RIA on Use Rule; number is likely to be too low based upon under-estimation of voluntary and mandated phaseout rate.

b) EEI/USWAG data

c) Assumption.

TOTAL PCB VOLUMES - REPLACEMENT/FAILURE - MINERAL OIL TRANSFORMERS


TOTAL NUMBER OF MINERAL OIL TRANSFORMERS CONTAINING SOME PCBs (1981 POPN.) 25,284,000[d]
FAILURE RATE = 0.2 %/YR[e] UNIT LIFE = 30 YEARS[f]
TOTAL NUMBER OF UNITS FOR "DISPOSAL" IN 1984 732,634[g]
TOTAL NUMBER OF MINERAL OIL UNITS FOR "DISPOSAL" IN 1984 732,634
@ 47.4 GAL/UNIT[h]
TOTAL FLUID VOLUME OF MINERAL OIL UNITS FOR "DISPOSAL" THAT CONTAIN SOME PCBs 34,726,852 GAL

d) Figure from Table S-1, July 1982 RIA on Use Rule.

e) Estimate used in July 1982 RIA on Use Rule.

f) Estimate used in July 1982 RIA on Use Rule except exclude rebuilding add-on of 30 years.

g) Number from sum of removal and failure estimated 1984 population; no additional units are added from voluntary phaseouts; losses in 1981-1983 (2,346,155 units) have been handled or are in storage.

h) Derived from Table S-1, July 1982 RIA on Use Rule.

INCINERATION CAPACITY UTILIZATION
PCB VOLUMES INCINERATED AND INCINERATION CAPACITY
(CONTINUED)

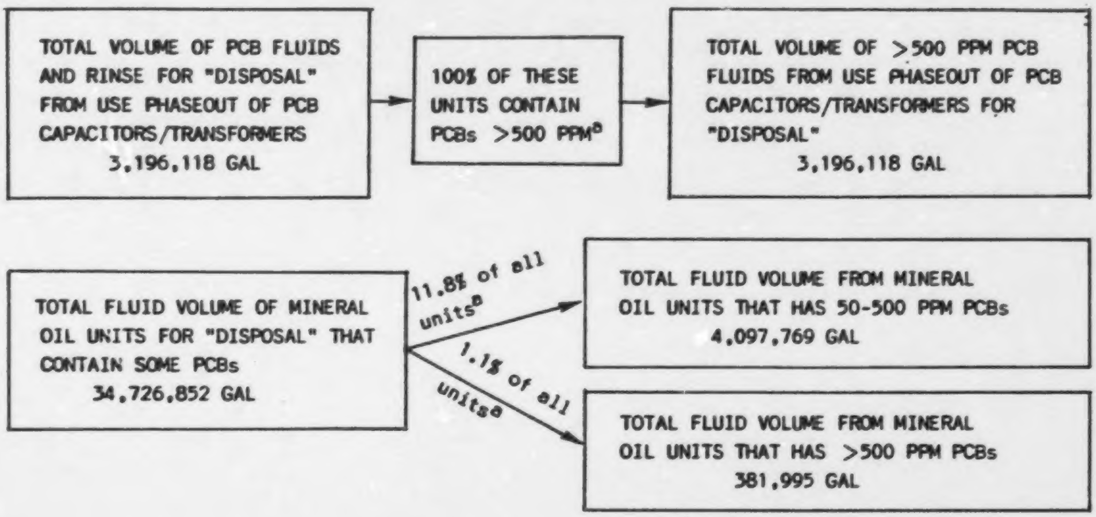
TOTAL PCB VOLUMES - IN STORAGE ("CARRYOVER" VOLUMES)

Estimate of carryover volumes of PCB - containing fluids could not be obtained from EPA or industry sources - industry sources do indicate, however, that offsite industry is at or near current PCB liquids incineration capacity - from estimated capacity number, therefore, and assuming capacity utilization to be 100 percent, have developed estimate of carryover volume from the following algorithm:

PCB liquids capacity (MT) x 100% = PCB liquids supply (MT) x 184 gal/MT = PCB liq. supply
PCB liquids supply (gal) - use phaseout volume (gal) - mineral oil units volume (gal)
= PCB carryover volume (gal)

Applying this algorithm, gives an estimate of 1,633,607 gallons (approximates volume from use phaseout of capacitors and transformers over 1981-83 according to Table 46, July 82 RIA on Use Rule).

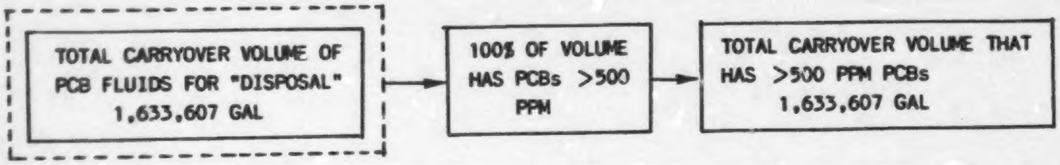
TOTAL PCB VOLUMES - BY PCB CONCENTRATION RANGE


TOTAL VOLUME OF PCB FLUIDS AND RINSE FOR "DISPOSAL" FROM USE PHASEOUT OF PCB CAPACITORS/TRANSFORMERS 3,196,118 GAL
100% OF THESE UNITS CONTAIN PCBs >500 PPM[a]
TOTAL VOLUME OF >500 PPM PCB FLUIDS FROM USE PHASEOUT OF PCB CAPACITORS/TRANSFORMERS FOR "DISPOSAL" 3,196,118 GAL
TOTAL FLUID VOLUME OF MINERAL OIL UNITS FOR "DISPOSAL" THAT CONTAIN SOME PCBs 34,726,852 GAL
11.8% of all units[a]
TOTAL FLUID VOLUME FROM MINERAL OIL UNITS THAT HAS 50-500 PPM PCBs 4,097,769 GAL
1.1% of all units[a]
TOTAL FLUID VOLUME FROM MINERAL OIL UNITS THAT HAS >500 PPM PCBs 381,995 GAL

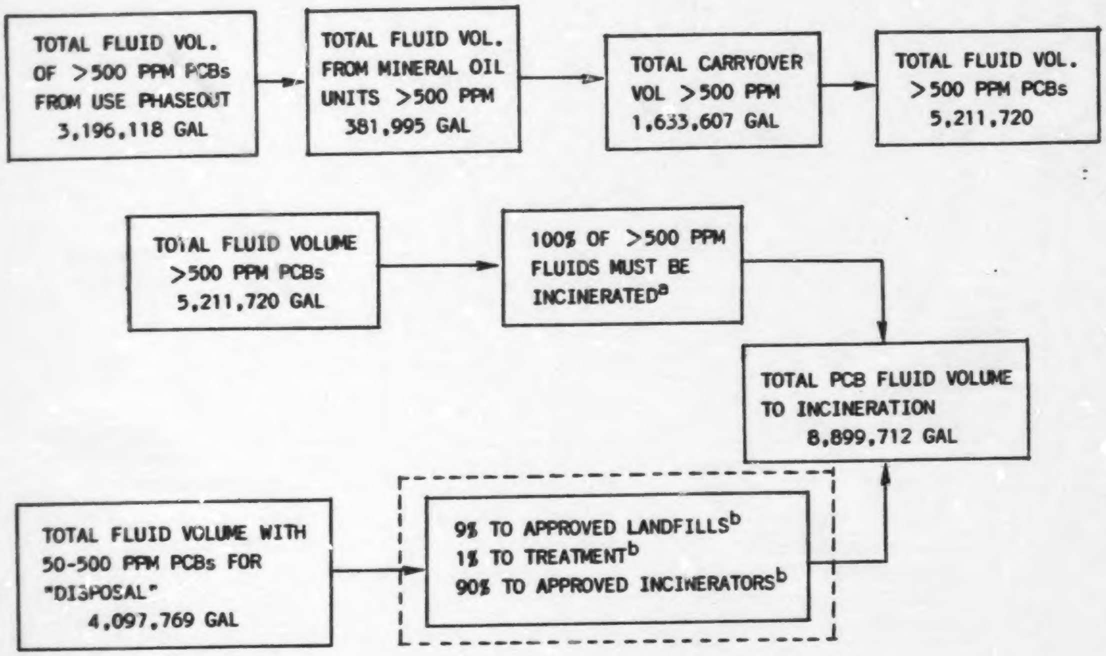
a) EEI/USWAG data.

INCINERATION CAPACITY UTILIZATION
PCB VOLUMES INCINERATED AND INCINERATION CAPACITY (CONT'D)

TOTAL PCB VOLUMES - BY PCB CONCENTRATION RANGE (Cont'd)


TOTAL CARRYOVER VOLUME OF PCB FLUIDS FOR "DISPOSAL" 1,633,607 GAL
100% OF VOLUME HAS PCBs >500 PPM
TOTAL CARRYOVER VOLUME THAT HAS >500 PPM PCBs 1,633,607 GAL

TOTAL PCB VOLUMES - NEEDING TO BE INCINERATED


TOTAL FLUID VOL. OF >500 PPM PCBs FROM USE PHASEOUT 3,196,118 GAL
TOTAL FLUID VOL. FROM MINERAL OIL UNITS >500 PPM 381,995 GAL
TOTAL CARRYOVER VOL >500 PPM 1,633,607 GAL
TOTAL FLUID VOL. >500 PPM PCBs 5,211,720
TOTAL FLUID VOLUME >500 PPM PCBs 5,211,720 GAL
100% OF >500 PPM FLUIDS MUST BE INCINERATED[a]
TOTAL PCB FLUID VOLUME TO INCINERATION 8,899,712 GAL
TOTAL FLUID VOLUME WITH 50-500 PPM PCBs FOR "DISPOSAL" 4,097,769 GAL
9% TO APPROVED LANDFILLS[b]
1% TO TREATMENT[b]
90% TO APPROVED INCINERATORS[b]

a) As specified by regulation.
b) Assumptions given regulatory options.

INCINERATION CAPACITY UTILIZATION
PCB VOLUMES INCINERATED AND INCINERATION CAPACITY (CONT'D)

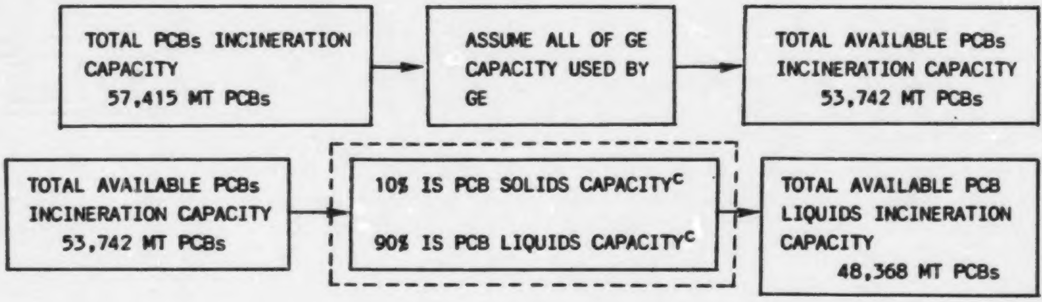
PCB INCINERATION CAPACITY

Four units approved for PCB incineration

Rollins	21.3×10^6 lbs PCB/yr =	9,660 MT PCBs/yr[a]
SCA	64.8×10^6 lbs PCB/yr =	29,388 MT PCBs/yr[a]
ENSCO	32.4×10^6 lbs PCB/yr =	14,694 MT PCBs/yr[a]
GE	8.1×10^6 lbs PCB/yr =	3,673 MT PCBs/yr[a]
	126.6×10^6 lbs PCB/yr	57,415 MT PCBs/yr[b]

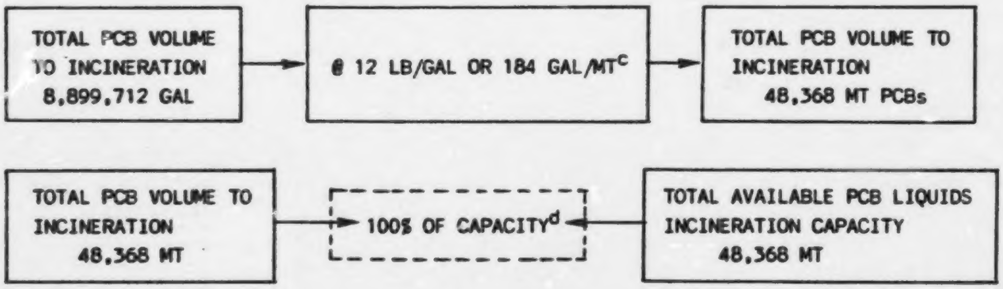
a) Figures supplied by OPTS

b) Verified by industry sources as in range.


TOTAL PCBs INCINERATION CAPACITY 57,415 MT PCBs
ASSUME ALL OF GE CAPACITY USED BY GE
TOTAL AVAILABLE PCBs INCINERATION CAPACITY 53,742 MT PCBs
TOTAL AVAILABLE PCBs INCINERATION CAPACITY 53,742 MT PCBs
10% IS PCB SOLIDS CAPACITY[c]
90% IS PCB LIQUIDS CAPACITY[c]
TOTAL AVAILABLE PCB LIQUIDS INCINERATION CAPACITY 48,368 MT PCBs

c) Assumption.

CAPACITY UTILIZATION ESTIMATES


TOTAL PCB VOLUME TO INCINERATION 8,899,712 GAL
@ 12 LB/GAL OR 184 GAL/MT[c]
TOTAL PCB VOLUME TO INCINERATION 48,368 MT PCBs
TOTAL PCB VOLUME TO INCINERATION 48,368 MT
100% OF CAPACITY[d]
TOTAL AVAILABLE PCB LIQUIDS INCINERATION CAPACITY 48,368 MT

d) Capacity utilization reported = 100% by industry sources.

EFFECTS OF LANDFILL RESTRICTIONS: MID-RANGE ESTIMATES CASE:

OBJECTIVE: To estimate incineration capacity utilization after imposition of restrictions on the landfilling of LOHWs

RESULTS: Demand for on-site incineration after restrictions are imposed is 42.8% of capacity

Demand for off-site incineration after restrictions are imposed id 214.7 % of capacity

KEY DATA: Total wastes generated = 264 MMT

Percent of wastes generated going to landfills = 1.2%

Baseline mid-range estimate of demand for off-site incineration = 0.139 MMT

Baseline mid-range estimate of demand for on-site incineration = 1.253 MMT

Net baseline off-site incineration capacity = 0.252 MMT

Baseline on-site incineration capacity = 3.10 MMT

KEY ASSUMPTIONS:

70% of wastes landfilled are landfilled off-site

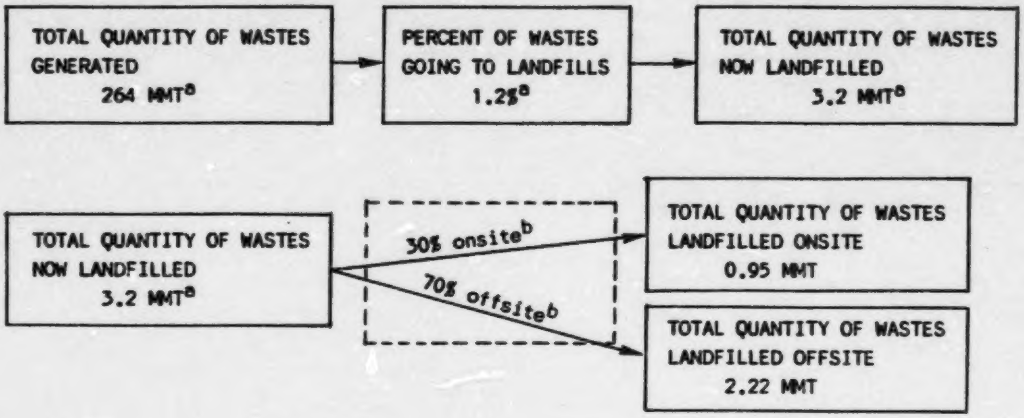
Landfill restrictions affect 50% of wastes currently landfilled

30% of restrictions-affected wastes are incinerable

84% of incinerable wastes are incinerated at commercial facilities

INCINERATION CAPACITY UTILIZATION
LAND DISPOSAL RESTRICTIONS
LANDFILL RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE

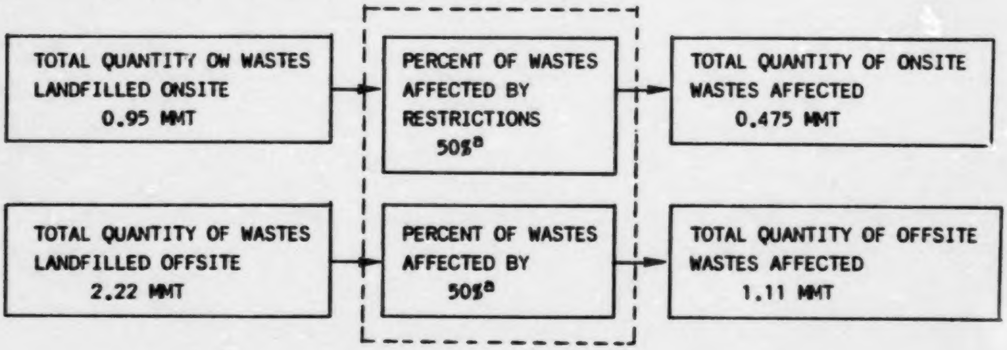
LANDFILLED VOLUMES


TOTAL QUANTITY OF WASTES GENERATED 264 MMT[a]
PERCENT OF WASTES GOING TO LANDFILLS 1.2%[a]
TOTAL QUANTITY OF WASTES NOW LANDFILLED 3.2 MMT[a]
TOTAL QUANTITY OF WASTES NOW LANDFILLED 3.2 MMT[a]
30% onsite[b]
70% offsite[b]
TOTAL QUANTITY OF WASTES LANDFILLED ONSITE 0.95 MMT
TOTAL QUANTITY OF WASTES LANDFILLED OFFSITE 2.22 MMT

a) 1981 RIA National Survey report data.

b) Are mid-range estimates determined from low-range estimates = 43% on-site, 57% off-site (RIA data) and high-range estimates = 16% on-site; 84% off-site (commercial industry annual survey data).

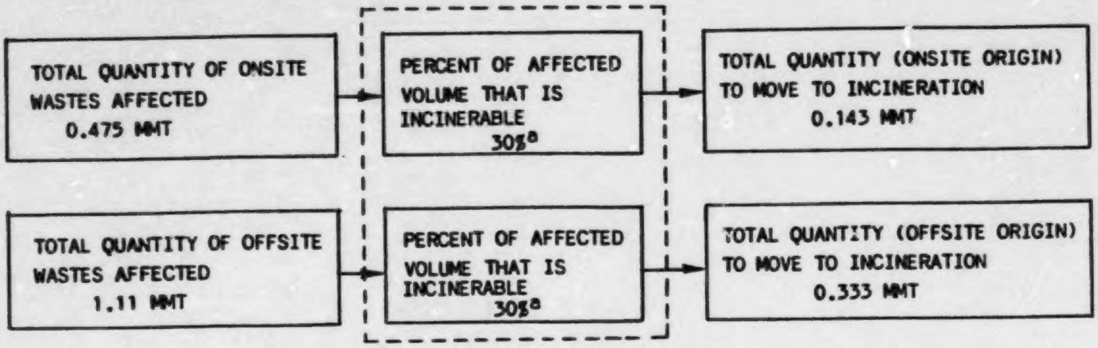
LANDFILL RESTRICTIONS EFFECTS


TOTAL QUANTITY OW WASTES LANDFILLED ONSITE 0.95 MMT
PERCENT OF WASTES AFFECTED BY RESTRICTIONS 50%[a]
TOTAL QUANTITY OF ONSITE WASTES AFFECTED 0.475 MMT
TOTAL QUANTITY OF WASTES LANDFILLED OFFSITE 2.22 MMT
PERCENT OF WASTES AFFECTED BY 50%[a]
TOTAL QUANTITY OF OFFSITE WASTES AFFECTED 1.11 MMT

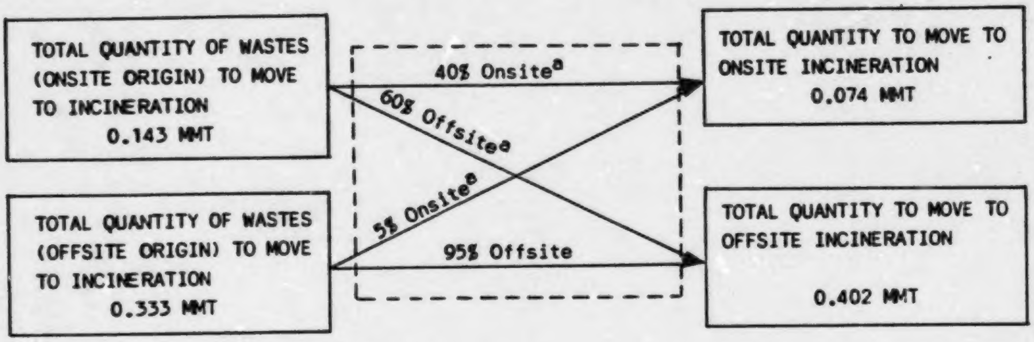
a) Range of 25% to 75% suggested by EPA staff as possible effects of restrictions. Mid-range estimate = 50%.

INCINERATION CAPACITY UTILIZATION
LANDFILL RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE (CONT'D)

LANDFILL RESTRICTIONS EFFECTS (Cont'd)


TOTAL QUANTITY OF ONSITE WASTES AFFECTED 0.475 MMT
PERCENT OF AFFECTED VOLUME THAT IS INCINERABLE 30%[a]
TOTAL QUANTITY (ONSITE ORIGIN) TO MOVE TO INCINERATION 0.143 MMT
TOTAL QUANTITY OF OFFSITE WASTES AFFECTED 1.11 MMT
PERCENT OF AFFECTED VOLUME THAT IS INCINERABLE 30%[a]
TOTAL QUANTITY (OFFSITE ORIGIN) TO MOVE TO INCINERATION 0.333 MMT

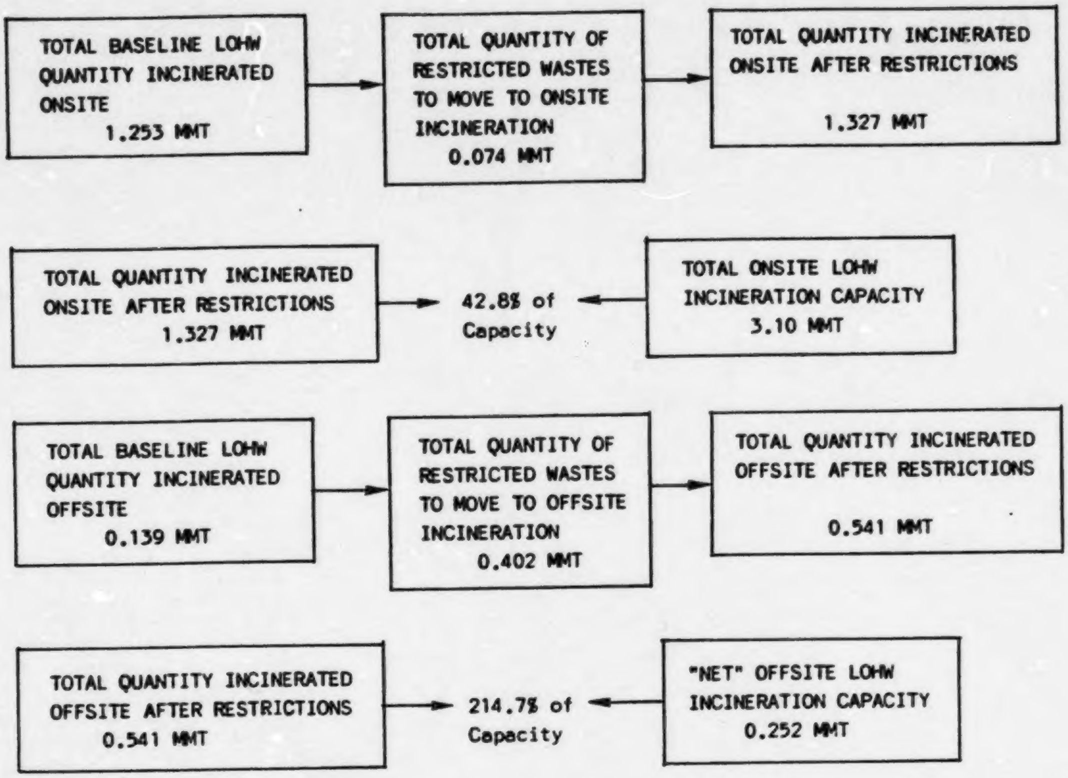
a) Assumes that to comply with restrictions, most of the wastes affected will be treated to still allow these wastes to be landfilled. Remainder of wastes that are affected but not amenable to chemical/physical/biological treatment will be incinerable and incinerated.


TOTAL QUANTITY OF WASTES (ONSITE ORIGIN) TO MOVE TO INCINERATION 0.143 MMT
TOTAL QUANTITY OF WASTES (OFFSITE ORIGIN) TO MOVE TO INCINERATION 0.333 MMT
40% Onsite[a]
60% Offsite[a]
5% Onsite[a]
95% Offsite
TOTAL QUANTITY TO MOVE TO ONSITE INCINERATION 0.074 MMT
TOTAL QUANTITY TO MOVE TO OFFSITE INCINERATION 0.402 MMT

a) Assumes that on the margin, the majority of generators originally managing their wastes on-site will elect to send these wastes to commercial facilities to be incinerated after the restrictions are in place. Decision will actually vary on basis of generator's waste management capabilities and perceptions of liabilities. Assumes that those wastes originally sent to commercial facilities will principally remain at commercial facilities to be incinerated.

INCINERATION CAPACITY UTILIZATION
LANDFILL RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE (CONT'D)

CAPACITY UTILIZATION ESTIMATES


TOTAL BASELINE LOHW QUANTITY INCINERATED ONSITE 1.253 MMT
TOTAL QUANTITY OF RESTRICTED WASTES TO MOVE TO ONSITE INCINERATION 0.074 MMT
TOTAL QUANTITY INCINERATED ONSITE AFTER RESTRICTIONS 1.327 MMT
TOTAL QUANTITY INCINERATED ONSITE AFTER RESTRICTIONS 1.327 MMT
42.8% of Capacity
TOTAL ONSITE LOHW INCINERATION CAPACITY 3.10 MMT
TOTAL BASELINE LOHW QUANTITY INCINERATED OFFSITE 0.139 MMT
TOTAL QUANTITY OF RESTRICTED WASTES TO MOVE TO OFFSITE INCINERATION 0.402 MMT
TOTAL QUANTITY INCINERATED OFFSITE AFTER RESTRICTIONS 0.541 MMT
TOTAL QUANTITY INCINERATED OFFSITE AFTER RESTRICTIONS 0.541 MMT
214.7% of Capacity
"NET" OFFSITE LOHW INCINERATION CAPACITY 0.252 MMT

EFFECTS OF DEEP WELL INJECTION RESTRICTIONS: MID-RANGE ESTIMATES CASE

OBJECTIVE:	To estimate on-site and off-site incineration capacity utilization after imposition of restrictions on underground injection of LOHWs
RESULTS:	On-site incineration capacity utilization after restrictions = 53.5% of capacity
	Off-site incineration capacity utilization after restrictions = 306.2% of capacity
KEY DATA:	Total wastes generated = 264 MMT
	Percent of wastes generated going to injection wells = 12.1%
	Baseline demand for on-site incineration (mid-range) = 1.253 MMT
	Baseline on-site incineration capacity = 3.1 MMT
	Baseline demand on off-site incineration (mid-range) = 0.139 MMT
	Net baseline off-site incineration capacity = 0.252 MMT

KEY ASSUMPTIONS:

97.5% of wastes injected are injected into on-site wells

Restrictions affect 50% of wastes injected

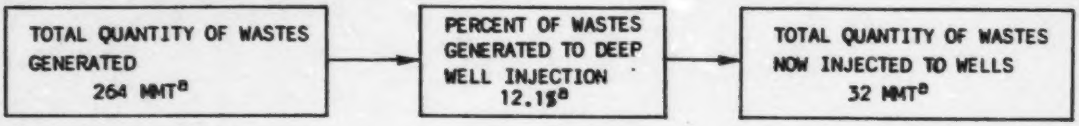
93.5% of affected wastes are non-incinerable

6.5% of affected wastes are incinerable either directly or as a result of pretreatment

60.9% of incinerable wastes are incinerated off-site

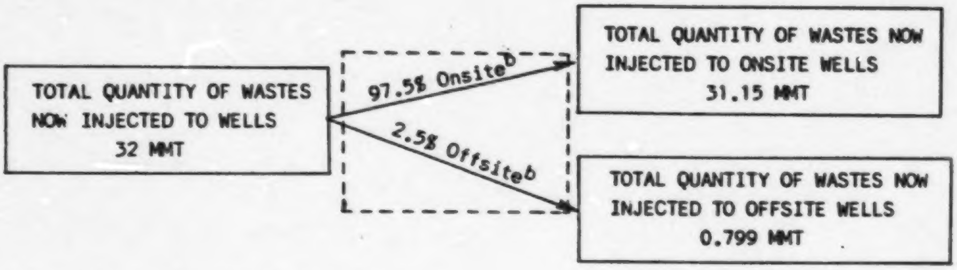
INCINERATION CAPACITY UTILIZATION
LAND DISPOSAL RESTRICTIONS
INJECTION WELL RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE

DEEP WELL INJECTION VOLUMES

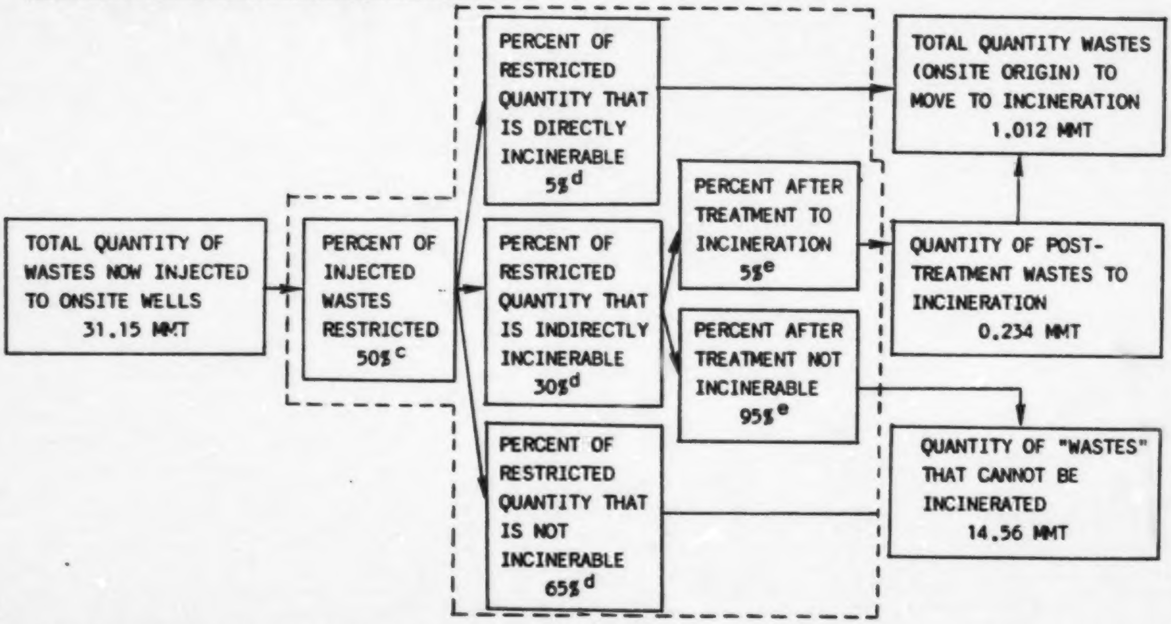

TOTAL QUANTITY OF WASTES GENERATED 264 MMT[a]
PERCENT OF WASTES GENERATED TO DEEP WELL INJECTION 12.1%[a]
TOTAL QUANTITY OF WASTES NOW INJECTED TO WELLS 32 MMT[a]

a) WESTAT report, April 1984.

b) Assumed estimates comperable to estimates derived from RIA data (see Appendix C).


TOTAL QUANTITY OF WASTES NOW INJECTED TO WELLS 32 MMT
97.5% Onsite[b]
2.5% Offsite[b]
TOTAL QUANTITY OF WASTES NOW INJECTED TO ONSITE WELLS 31.15 MMT
TOTAL QUANTITY OF WASTES NOW INJECTED TO OFFSITE WELLS 0.799 MMT

EFFECTS OF DEEP WELL INJECTION RESTRICTIONS


TOTAL QUANTITY OF WASTES NOW INJECTED TO ONSITE WELLS 31.15 MMT
PERCENT OF INJECTED WASTES RESTRICTED 50%[c]
PERCENT OF RESTRICTED QUANTITY THAT IS DIRECTLY INCINERABLE 5%[d]
PERCENT OF RESTRICTED QUANTITY THAT IS INDIRECTLY INCINERABLE 30%[d]
PERCENT OF RESTRICTED QUANTITY THAT IS NOT INCINERABLE 65%[d]
PERCENT AFTER TREATMENT TO INCINERATION 5%[e]
PERCENT AFTER TREATMENT NOT INCINERABLE 95%[e]
TOTAL QUANTITY WASTES (ONSITE ORIGIN) TO MOVE TO INCINERATION 1.012 MMT
QUANTITY OF POST-TREATMENT WASTES TO INCINERATION 0.234 MMT
QUANTITY OF "WASTES" THAT CANNOT BE INCINERATED 14.56 MMT

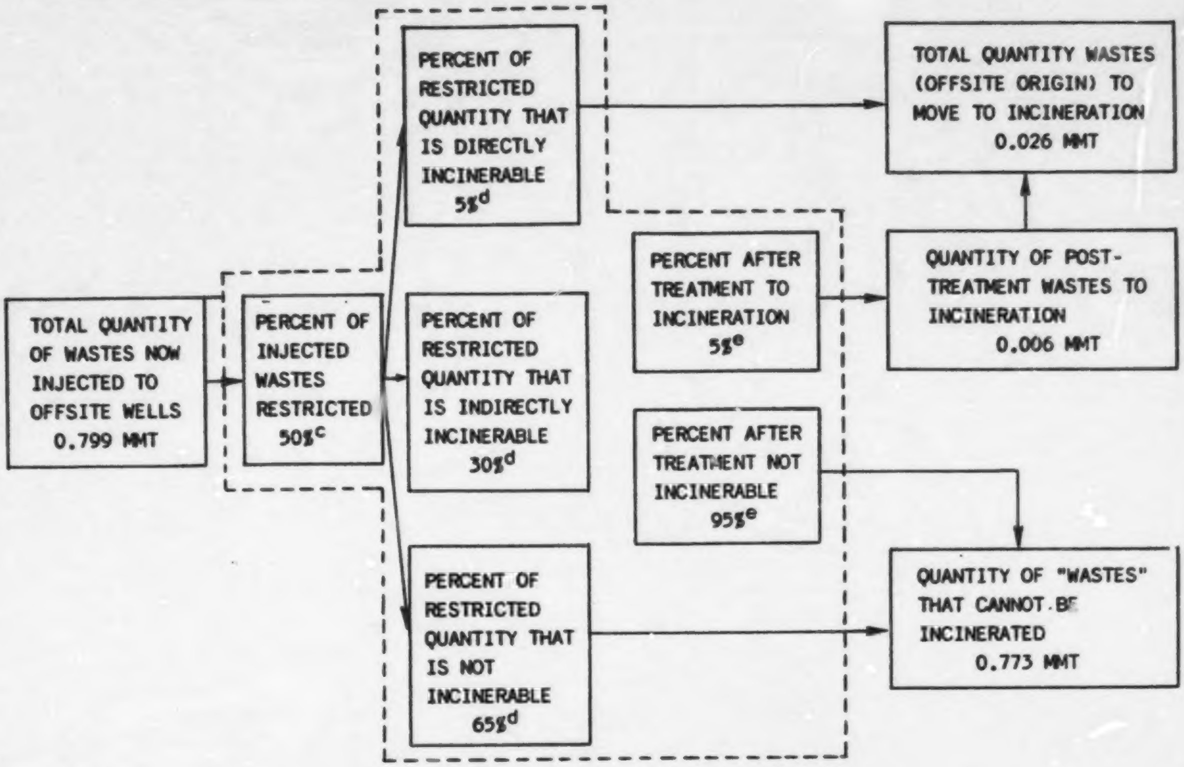
c) Range of estimates suggested by EPA staff = 25% to 75%. Mid-range = 50%.

d) Assumes most of affected wastes are not incinerable, small percentage are directly incinerable, and some are incinerable if treated first.

e) After treatment, volume to be incinerated is assumed to be small.

INCINERATION CAPACITY UTILIZATION
INJECTION WELL RESTRICTIONS: MID-RANGE ESTIMATES CASE (CONT'D)

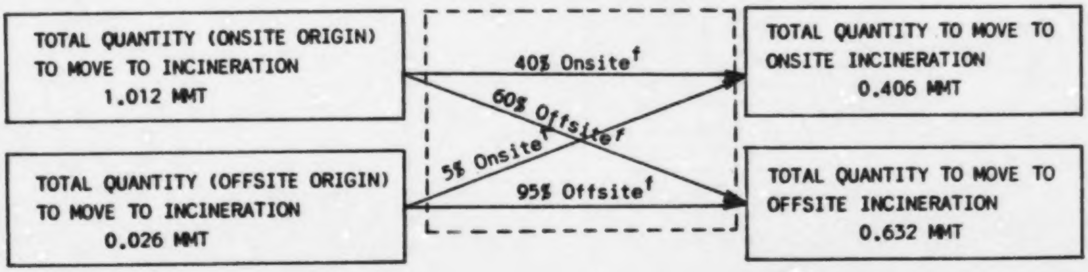
EFFECTS OF DEEP WELL INJECTION RESTRICTIONS (CONT'D)


TOTAL QUANTITY OF WASTES NOW INJECTED TO OFFSITE WELLS 0.799 MMT
PERCENT OF INJECTED WASTES RESTRICTED 50%[c]
PERCENT OF RESTRICTED QUANTITY THAT IS DIRECTLY INCINERABLE 5%[d]
PERCENT OF RESTRICTED QUANTITY THAT IS INDIRECTLY INCINERABLE 30%[d]
PERCENT OF RESTRICTED QUANTITY THAT IS NOT INCINERABLE 65%[d]
PERCENT AFTER TREATMENT TO INCINERATION 5%[e]
PERCENT AFTER TREATMENT NOT INCINERABLE 95%[e]
TOTAL QUANTITY WASTES (OFFSITE ORIGIN) TO MOVE TO INCINERATION 0.026 MMT
QUANTITY OF POST-TREATMENT WASTES TO INCINERATION 0.006 MMT
QUANTITY OF "WASTES" THAT CANNOT BE INCINERATED 0.773 MMT

c) Range of estimates suggested by EPA staff = 25% to 75%. Mid-range = 50%.

d) Assumes most of affected wastes are not incinerable, small percentage are directly incinerable, and some are incinerable if treated first.

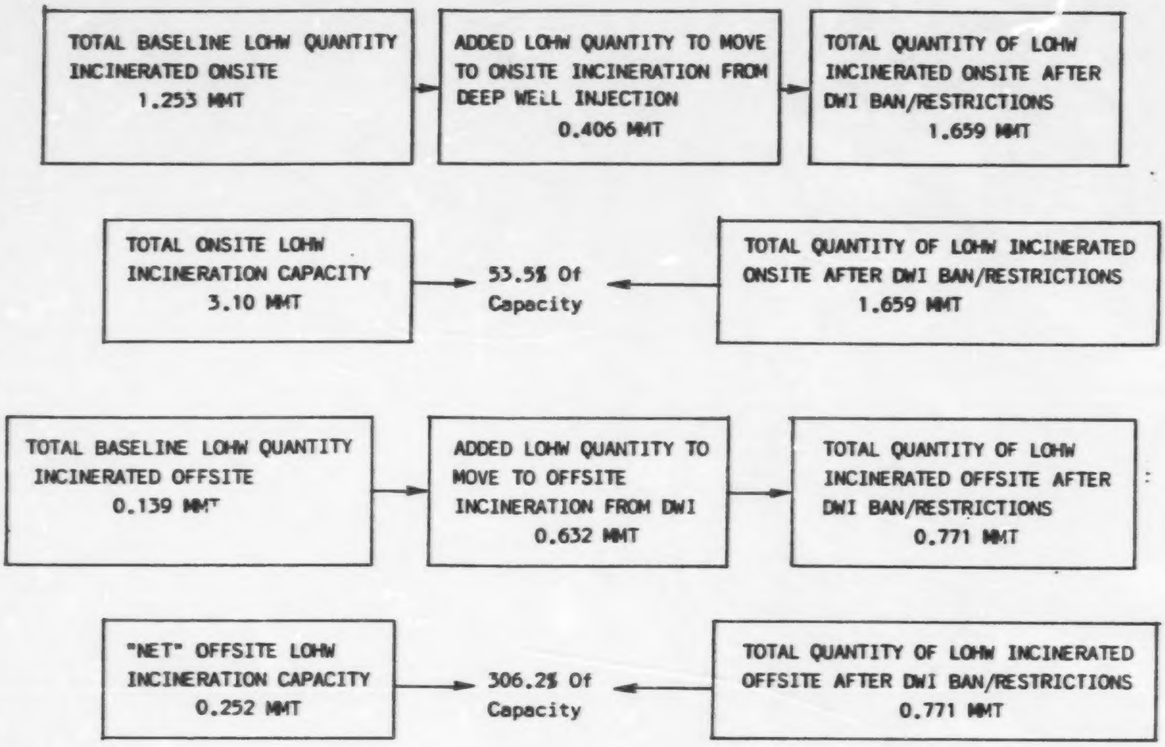
e) After treatment, volume to be incinerated is assumed to be small.


TOTAL QUANTITY (ONSITE ORIGIN) TO MOVE TO INCINERATION 1.012 MMT
TOTAL QUANTITY (OFFSITE ORIGIN) TO MOVE TO INCINERATION 0.026 MMT
40% Onsite[f]
60% Offsite[f]
5% Onsite[f]
95% Offsite[f]
TOTAL QUANTITY TO MOVE TO ONSITE INCINERATION 0.406 MMT
TOTAL QUANTITY TO MOVE TO OFFSITE INCINERATION 0.632 MMT

f) Assumes that on the margin, the majority of generators originally managing their wastes on-site will elect to send these wastes off-site to be incinerated after restrictions are in-place. Wastes originally sent off-site will remain off-site.

INCINERATION CAPACITY UTILIZATION
INJECTION WELL RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE (CONT'D)

CAPACITY UTILIZATION ESTIMATES


TOTAL BASELINE LOHW QUANTITY INCINERATED ONSITE 1.253 MMT
ADDED LOHW QUANTITY TO MOVE TO ONSITE INCINERATION FROM DEEP WELL INJECTION 0.406 MMT
TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER DWI BAN/RESTRICTIONS 1.659 MMT
TOTAL ONSITE LOHW INCINERATION CAPACITY 3.10 MMT
53.5% Of Capacity
TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER DWI BAN/RESTRICTIONS 1.659 MMT
TOTAL BASELINE LOHW QUANTITY INCINERATED OFFSITE 0.139 MMT
ADDED LOHW QUANTITY TO MOVE TO OFFSITE INCINERATION FROM DWI 0.632 MMT
TOTAL QUANTITY OF LOHW INCINERATED OFFSITE AFTER DWI BAN/RESTRICTIONS 0.771 MMT
"NET" OFFSITE LOHW INCINERATION CAPACITY 0.252 MMT
306.2% Of Capacity
TOTAL QUANTITY OF LOHW INCINERATED OFFSITE AFTER DWI BAN/RESTRICTIONS 0.771 MMT

EFFECTS OF A DISPOSAL IMPOUNDMENT BAN: MID-RANGE ESTIMATES CASE

OBJECTIVE:	To estimate on-site and off-site incineration capacity utilization after imposition of a ban on disposing LOHWs in surface impoundments
RESULTS:	On-site incineration capacity utilization after ban = 52.1%
	Off-site incineration capacity utilization after ban = 288.2% of capacity
KEY DATA:	Total wastes generated = 264 MMT
	Percent of wastes generated going to disposal impoundments = 7.2%
	Baseline on-site incineration demand (mid-range) = 1.253 MMT
	Baseline on-site incineration capacity = 3.10 MMT
	Baseline off-site incineration demand (mid-range) = 0.139 MMT
	Net baseline off-site incineration capacity 0.252 MMT

KEY ASSUMPTIONS:

95% of wastes to on-site disposal impoundments

10% of wastes in disposal impoundments are incinerable

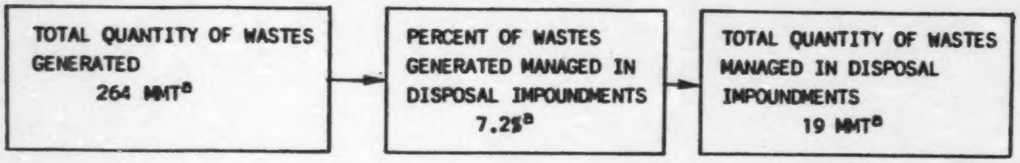
50% of incinerable wastes are incinerated

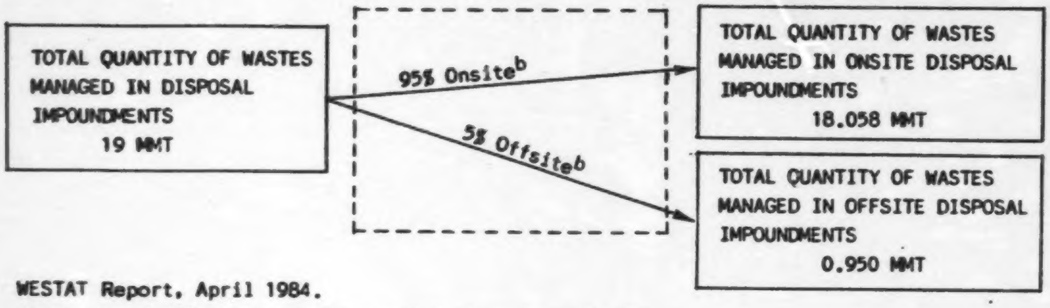
61.7% of wastes incinerated are incinerated off-site

Complete prohibition of practice

INCINERATION CAPACITY UTILIZATION
LAND DISPOSAL RESTRICTIONS
DISPOSAL IMPOUNDMENTS BAN EFFECTS: MID-RANGE ESTIMATES CASE

DISPOSAL IMPOUNDMENT VOLUMES

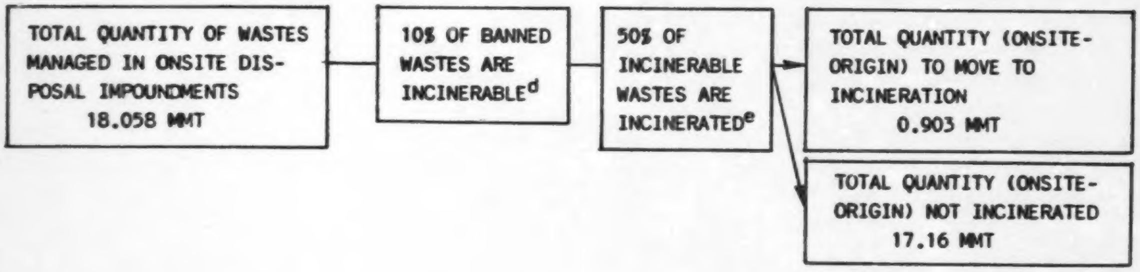

TOTAL QUANTITY OF WASTES GENERATED 264 MMT[a]
PERCENT OF WASTES GENERATED MANAGED IN DISPOSAL IMPOUNDMENTS 7.2%[a]
TOTAL QUANTITY OF WASTES MANAGED IN DISPOSAL IMPOUNDMENTS 19 MMT[a]

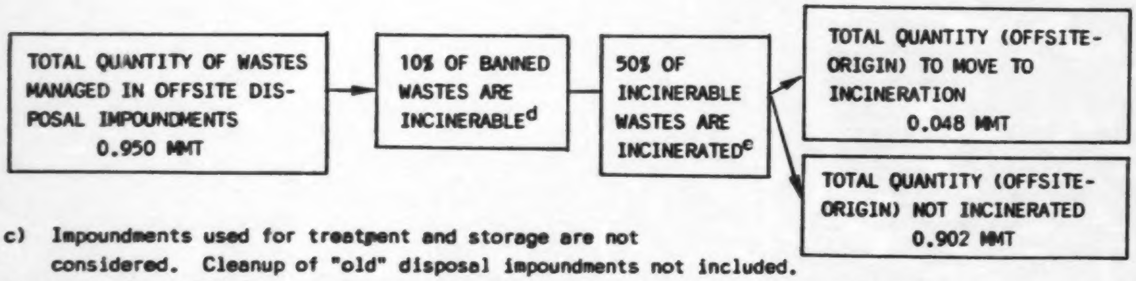

TOTAL QUANTITY OF WASTES MANAGED IN DISPOSAL IMPOUNDMENTS 19 MMT
95% Onsite[b]
5% Offsite[b]
TOTAL QUANTITY OF WASTES MANAGED IN ONSITE DISPOSAL IMPOUNDMENTS 18.058 MMT
TOTAL QUANTITY OF WASTES MANAGED IN OFFSITE DISPOSAL IMPOUNDMENTS 0.950 MMT

a) WESTAT Report, April 1984.

b) Analysis of 1981 National Survey data (see Appendix C).

EFFECTS OF A BAN ON WASTE DISPOSAL IMPOUNDMENTS[c]


TOTAL QUANTITY OF WASTES MANAGED IN ONSITE DISPOSAL IMPOUNDMENTS 18.058 MMT
10% OF BANNED WASTES ARE INCINERABLE[d]
50% OF INCINERABLE WASTES ARE INCINERATED[e]
TOTAL QUANTITY (ONSITE-ORIGIN) TO MOVE TO INCINERATION 0.903 MMT
TOTAL QUANTITY (ONSITE-ORIGIN) NOT INCINERATED 17.16 MMT


TOTAL QUANTITY OF WASTES MANAGED IN OFFSITE DISPOSAL IMPOUNDMENTS 0.950 MMT
10% OF BANNED WASTES ARE INCINERABLE[d]
50% OF INCINERABLE WASTES ARE INCINERATED[e]
TOTAL QUANTITY (OFFSITE-ORIGIN) TO MOVE TO INCINERATION 0.048 MMT
TOTAL QUANTITY (OFFSITE-ORIGIN) NOT INCINERATED 0.902 MMT

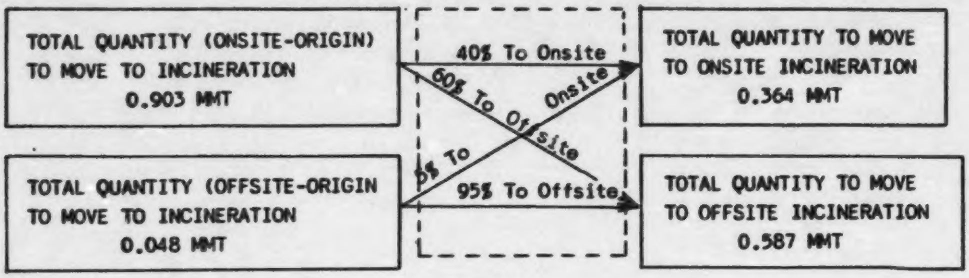
c) Impoundments used for treatment and storage are not considered. Cleanup of "old" disposal impoundments not included.

d) Analysis of RIA National Survey. Represents percentage of LOHWs in disposal impoundments out of all wastes managed in disposal impoundments.

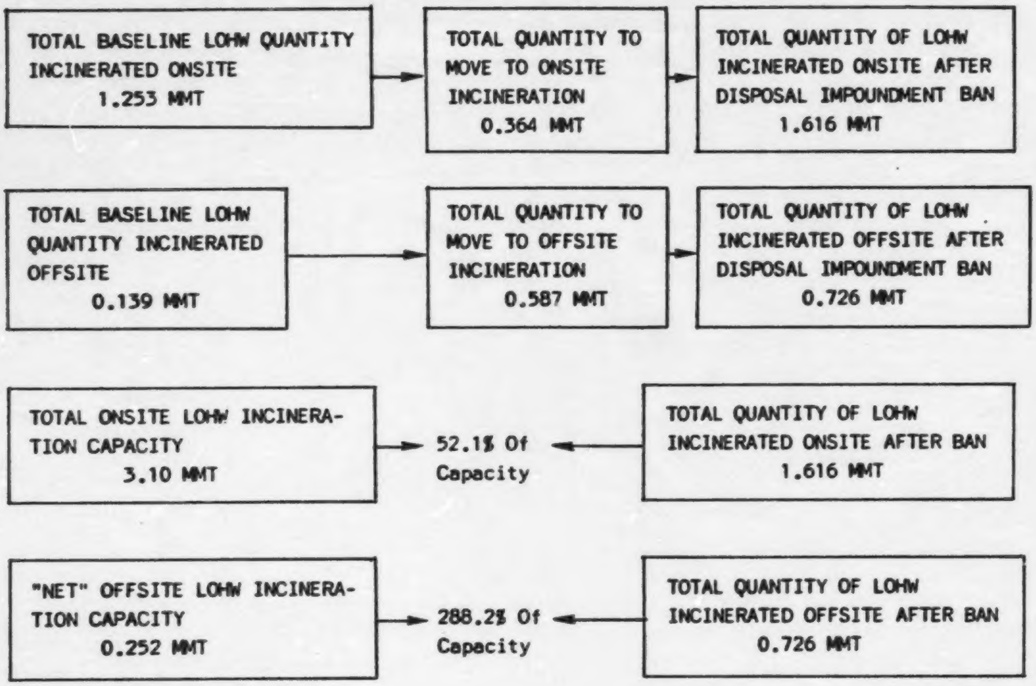
e) Range of estimates suggested by EPA staff = 25% to 75%. Mid-range = 50%.

INCINERATION CAPACITY UTILIZATION
DISPOSAL IMPOUNDMENTS BAN EFFECTS: MID-RANGE ESTIMATES CASE (CONT'D)

EFFECTS OF A BAN ON WASTE DISPOSAL IMPOUNDMENTS (CONT'D)


TOTAL QUANTITY (ONSITE-ORIGIN) TO MOVE TO INCINERATION 0.903 MMT
TOTAL QUANTITY (OFFSITE-ORIGIN TO MOVE TO INCINERATION 0.048 MMT
40% To Onsite
60% To Offsite
5% To Onsite
95% To Offsite
TOTAL QUANTITY TO MOVE TO ONSITE INCINERATION 0.364 MMT
TOTAL QUANTITY TO MOVE TO OFFSITE INCINERATION 0.587 MMT

CAPACITY UTILIZATION ESTIMATE


TOTAL BASELINE LOHW QUANTITY INCINERATED ONSITE 1.253 MMT
TOTAL QUANTITY TO MOVE TO ONSITE INCINERATION 0.364 MMT
TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER DISPOSAL IMPOUNDMENT BAN 1.616 MMT
TOTAL BASELINE LOHW QUANTITY INCINERATED OFFSITE 0.139 MMT
TOTAL QUANTITY TO MOVE TO OFFSITE INCINERATION 0.587 MMT
TOTAL QUANTITY OF LOHW INCINERATED OFFSITE AFTER DISPOSAL IMPOUNDMENT BAN 0.726 MMT
TOTAL ONSITE LOHW INCINERATION CAPACITY 3.10 MMT
52.1% Of Capacity
TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER BAN 1.616 MMT
"NET" OFFSITE LOHW INCINERATION CAPACITY 0.252 MMT
288.2% Of Capacity
TOTAL QUANTITY OF LOHW INCINERATED OFFSITE AFTER BAN 0.726 MMT

EFFECTS OF WASTES-IN-BOILERS RESTRICTIONS: MID-RANGE ESTIMATES CASE

OBJECTIVE:	To estimate on-site and off-site incineration capacity utilization after imposition of restrictions on the burning of hazardous wastes in industrial boilers
RESULTS:	On-site incineration capacity utilization after restrictions = 42.2% of capacity Off-site incineration capacity utilization after restrictions = 106.3% of capacity
KEY DATA:	Total hazardous wastes burned in boilers = 0.7 MMT Baseline on-site incineration demand (mid-range) = 1.253 MMT Baseline on-site incineration capacity = 3.10 MMT Baseline off-site incineration demand (mid-range) = 0.139 MMT Net baseline off-site incineration capacity = 0.252 MMT
KEY ASSUMPTIONS:	35% of boiler population affected by restrictions

KEY ASSUMPTIONS: (Continued)

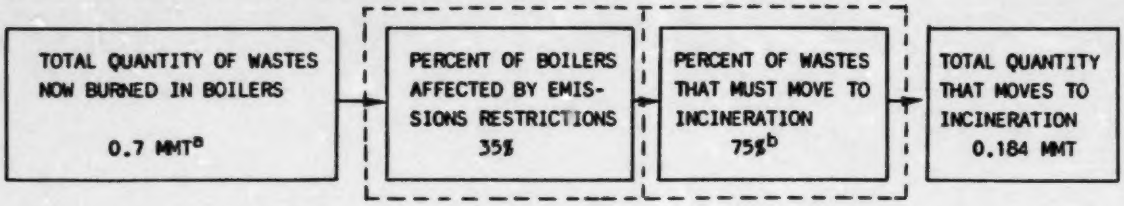
All boilers in population have same capacity

75% of wastes from restriction-affected boilers are incinerated

70% of incinerated wastes are incinerated off-site

INCINERATION CAPACITY UTILIZATION
WASTES-IN-BOILERS RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE

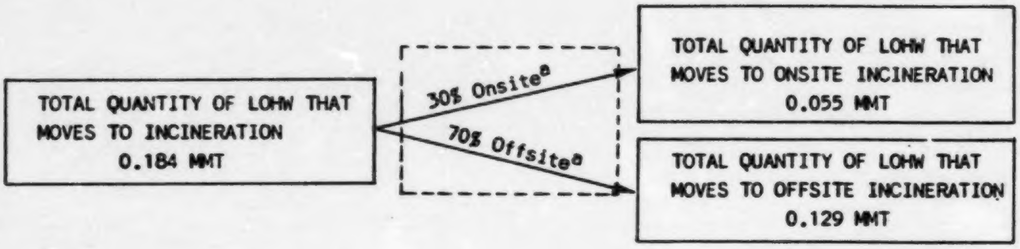
WASTE-IN-BOILERS RESTRICTIONS EFFECTS


TOTAL QUANTITY OF WASTES NOW BURNED IN BOILERS
0.7 MMT[a]
PERCENT OF BOILERS AFFECTED BY EMISSIONS RESTRICTIONS
35%
PERCENT OF WASTES THAT MUST MOVE TO INCINERATION
75%[b]
TOTAL QUANTITY THAT MOVES TO INCINERATION
0.184 MMT

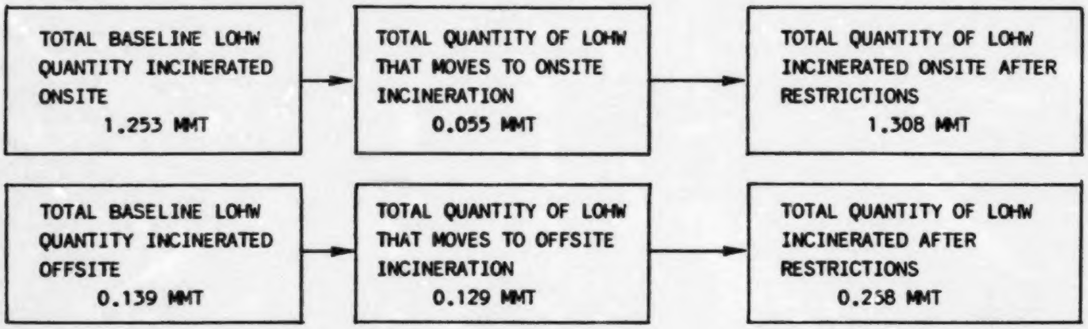
a) Estimate derived from EPA wastes-in-boilers study.

b) Range of estimates suggested by EPA staff = 50% to 100%. Mid-range = 75%.

ONSITE VS. OFFSITE VOLUMES


TOTAL QUANTITY OF LOHW THAT MOVES TO INCINERATION
0.184 MMT
30% Onsite[a]
70% Offsite[a]
TOTAL QUANTITY OF LOHW THAT MOVES TO ONSITE INCINERATION
0.055 MMT
TOTAL QUANTITY OF LOHW THAT MOVES TO OFFSITE INCINERATION
0.129 MMT

a) Assumes that most of wastes will have to be incinerated off-site.


TOTAL BASELINE LOHW QUANTITY INCINERATED ONSITE
1.253 MMT
TOTAL QUANTITY OF LOHW THAT MOVES TO ONSITE INCINERATION
0.055 MMT
TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER RESTRICTIONS
1.308 MMT
TOTAL BASELINE LOHW QUANTITY INCINERATED OFFSITE
0.139 MMT
TOTAL QUANTITY OF LOHW THAT MOVES TO OFFSITE INCINERATION
0.129 MMT
TOTAL QUANTITY OF LOHW INCINERATED AFTER RESTRICTIONS
0.258 MMT

INCINERATION CAPACITY UTILIZATION
WASTES-IN-BOILERS RESTRICTIONS EFFECTS: MID-RANGE ESTIMATES CASE (CONT'D)

CAPACITY UTILIZATION ESTIMATES

TOTAL QUANTITY OF LOHW INCINERATED ONSITE AFTER RESTRICTIONS
1.308 MMT

← 42.2% Of Capacity →

TOTAL ONSITE LIQUIDS INCINERATION CAPACITY
3.10 MMT[a]

TOTAL QUANTITY OF LOHW INCINERATED OFFSITE AFTER RESTRICTIONS
0.268 MMT

← 106.3% Of Capacity →

"NET" OFFSITE LOHW INCINERATION CAPACITY
0.252 MMT[a]

a) Assumes no change in "net" capacity and that all of capacity is available.

INCINERATION-AT-SEA CAPACITY

OBJECTIVE:	To estimate the probable incineration-at-sea capacity that could be added to land-based incineration capacity
RESULTS:	Total incineration-at-sea capacity = 0.297 MMT/yr
KEY DATA:	Metric tons/voyage for six incinerator ships
	Estimated turn-around times for six incinerator ships
KEY ASSUMPTIONS:	Operate at full capacity each voyage
	Number of voyages per year are two less than maximum possible on basis of estimated turn-around times

INCINERATION CAPACITY UTILIZATION
INCINERATION-AT-SEA CAPACITY

VULCANUS I & II (Ocean Combustion Services - Chemical Waste Management)

VULCANUS I: 3,600 MT/voyage x 16 voyages/yr[a] = 57,600 MT/yr

VULCANUS II: 3,600 MT/voyage x 16 voyages/yr[a] = 57,600 MT/yr

115,200 MT/yr

a) derived from information supplied by OWRS; permit application indicates plan to burn 350,000 MT over 3 years between the two ships, an estimated turn-around time of 3 weeks (5 days in-transit, 10 days to burn, 5 days to reload), 2 units on Vulcanus I, 3 units on Vulcanus II, each unit with throughput of (per unit) 1,650 gal/hr @ 10 lb/gal, 240 hrs of burning; assume loss of 1 voyages/yr off maximum of 17 (52 wks ÷ 3); termed reasonable by OWRS, likely even fewer given logistics problems, seasonal limitations on operation, etc.

APPOLLO I & II (At-Sea Incineration Inc.)

APPOLLO I: 1.31×10^{b} gal/voyage $\approx$ 6000 MT/voyage x 22 voyages/yr[b] =132,000 MT/yr

132,000 MT/yr

b) derived from information supplied by OWRS; estimated turn-around time of 2 weeks (2 days in-transit, 10 days to burn, 2 days to reload), 2 units each on both ships, 2,750 gal/hr/unit, @ 10 lb/gal, 240 hrs. of burning; assume loss of 4 voyages/yr off maximum of 26 (52 wks ÷ 2); termed reasonable by OWRS, likely even fewer given logistics problems, seasonal limitations on operations, etc.

EFFECTS OF SUPERFUND CLEAN-UP ACTIVITY ON RCRA CAPACITY

OBJECTIVE:	To estimate quantity of wastes that are incinerable and are incinerated from past and future Superfund remedial and removal actions
RESULTS:	None
KEY DATA:	None directly available
KEY ASSUMPTIONS:	None

INCINERATION CAPACITY UTILIZATION

EFFECTS OF SUPERFUND CLEAN-UP ACTIVITIES ON RCRA CAPACITY

Little technology-specific and waste type-specific data are directly available concerning present and/or future waste quantities removed from Superfund sites to RCRA facilities. Data sources with this information are not collected in one place, and are inconsistent in their degree of detail (e.g., lack waste type information). A compilation of these sources is recommended.

Some information has been analyzed and made available for this market study. Waste quantities incinerated are not known.

Wastes excavated and disposed off-site from Superfund remedial sites[a] = 178,697 metric tons (235,127 cu.yds @ 0.76 metric tons per cu. yds.)

EPA Region	Waste Quantity Disposed Off-Site (metric tons)
I	7,883
II	4,115
III	16,671
IV	-
V	28,869
VI	14,440
VII	-
VIII	-
IX	106,719
X	-
	178,697

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a) Sites that have a signed Record of Decision, where excavation and disposal off-site was cost-effective remedial alternative. Disposal means land disposal only.

ORGANIC LIQUIDS LIKELY TO BE LISTED

OBJECTIVE:	To estimate quantity of wastes added from the listing of organic liquids as hazardous wastes
RESULTS:	Total added quantity could be 1.2 MMT/yr 23% of these wastes are currently incinerated 90% of these organic liquids are presently managed on-site
KEY DATA:	Quantities of organic liquids likely to be listed as a result of the Industry Studies Program Quantities managed on-site and off-site by technology
KEY ASSUMPTIONS:	49% of organic liquids studied in the Industry Studies Program are likely to be listed Industry Studies data base contains data on 59% of the total industry Likely impact small as most of these wastes are already managed at RCRA permitted facilities

INCINERATION CAPACITY UTILIZATION
ORGANIC LIQUIDS LIKELY TO BE LISTED AS A RESULT OF THE INDUSTRY STUDIES PROGRAM[a]

An estimated 1.2 million metric tons of organic liquids could be added to hazardous waste volumes. Presently, 23 percent of these liquids are incinerated, most on-site.

MANAGEMENT TECHNOLOGY/METHOD	QUANTITY MANAGED ON-SITE (metric tons/yr)	QUANTITY MANAGED OFF-SITE (metric tons/yr)	TOTAL QUANTITY (metric tons/yr)
Treatment in Tanks	10,028	0	10,028 (0.8)
Treatment in Surf. Impd.	104,874	871	105,745 (8.8)
Recovery	188,922	45,275	234,197 (19.5)
Reuse	69,280	N.A.	69,280 (5.8)
Sales	N.A.	53,982	53,982 (4.5)
Landfill	698	5,596	6,294 (0.5)
Burned in Boilers	423,321	756	424,077 (35.3)
Incineration	266,449	7,505	273,954 (22.8)
Injection Well	22,329	2,909	25,238 (2.1)
Land Application	-	-	-
TOTALS	1,085,901	116,894	1,202,795[b]

N.A. = Not applicable

(Numbers in parentheses are percents of total)

a) Data provided through OSW. Assumes that:

- 60% of Industry Studies manufacturers who provided waste management data also reported waste quantities
- Industry Studies data base contains data on 59% of total industry
- 49% of organic liquids studied in the Industry Studies Program are likely to be listed (weight basis).

b) Represents possible additional waste volume added to current LOHW totals. In actuality, may only be some fraction of this as some of wastes already handled at RCRA TSDs.

APPENDIX D

LOW-RANGE AND HIGH-RANGE ESTIMATE CASE SUMMARIES

For several of the key data and assumptions in this market analysis, sources consulted have suggested that the available data are too uncertain or incomplete to support a single "best" estimate. Instead, they suggest, there may be a range of likely estimates that should be incorporated into the analysis. This has been accomplished through a sensitivity analysis that examines variations in the demand for incineration under each regulatory scenario, based upon the range of likely estimates provided.

In Appendix C, logic diagrams that trace the key data, assumptions, and results in each module have been constructed using the mid-range or mid-point value of the estimate ranges suggested. These mid-range estimates results are considered the best average assuming, that for any one assumption, either the lower or higher estimate suggested may actually be "correct." Chapters II, III, and IV also use these mid-range estimates results, as does the incineration equivalents analysis in Chapter VI, however, results of the sensitivity analysis have been included in these discussions.

Variations to the mid-range estimates case are summarized in this appendix. Only those key data and assumptions for which sources have suggested a possible lower and higher value are covered. All other data and assumptions were held fixed across the low-range, mid-range, and high-range estimate cases. Results of the low-range and high-range estimate cases are not presented here, but are covered in Chapters II, III, and IV. These alternate values can be used in place of the mid-range estimates in the logic diagrams in Appendix C to calculate alternate incineration capacity utilization outcomes.

EXHIBIT D-1
Variations In Key Assumptions/Data Across Sensitivity Analysis Cases For Each Market Analysis Module

Market Analysis Module	Low-Range Estimates Case	Mid-Range Estimates Case	High-Range Estimates Case
A. BASELINE INCINERATION CAPACITY UTILIZATION			
• Total LOHWs incinerated (MMT)*	0.928	1.392	1.856
• Percent commercial capacity utilization	37	55	74
B. LANDFILL RESTRICTIONS EFFECTS			
• Percent wastes presently landfilled on-site:off-site	43:57	30:70	16:84
• Percent wastes affected by restrictions	25	50	75
C. DEEP WELL INJECTION RESTRICITONS EFFECTS			
• Percent injected wastes affected by restrictions	25	50	75
D. DISPOSAL IMPOUNDMENTS BAN EFFECTS			
• Percent of incinerable wastes that are incinerated	25	50	75
E. WASTE-IN-BOILERS RESTRICTIONS EFFECTS			
• Percent of wastes from affected boilers that are incinerated	50	75	100

*Established as a function of the range of estimates suggested by sources for commercial incineration capacity utilization (40-80%) against a fixed total incineration capacity for LOHWs = 3.4 MMT, and a fixed "net" commercial incineration capacity for LOHWs = 0.300 MMT.

APPENDIX E

DEFINITIONS OF SELECTED TERMS USED IN THE MARKET ANALYSIS

How terms such as a "commercial" facility or "off-site" wastes are defined can influence what gets counted or considered in the development of each market analysis estimate or assumption. More commercial capacity gets counted, for example, if a commercial facility, handling mostly other firm's wastes, can be either privately or publicly owned and operated rather than only privately owned and operated. Differences in terminology may also be behind apparently dissimilar estimates for the same parameter in different sources.

The following defines how individual terms have been used in the incineration market analysis. These definitions apply unless noted otherwise. How these terms may differ in their usage than in other sources cited (e.g., the RIA National Survey report) is also explained.

- Commercial or Off-site Commercial Facility. A commercial facility or off-site commercial facility refers to a hazardous waste management facility that:

  - Is privately owned and operated

  - Receives a fee for its services

  - Receives "most" of its wastes managed from firms or other facilities that are not associated by ownership (i.e., "other" firms)

  - Receives other firm wastes assumed to have been generated and shipped from off-site.

  This definition excludes facilities that mostly handle wastes from other firms for a fee, but are publicly owned and operated (see definition of a noncommercial facility). Determination of what threshold constitutes "mostly" other firm wastes varies by technology (see Appendix B), however, it is interpreted to not exclude the possibility of intrafirm shipments of wastes between commercial facilities under the same ownership. As used here, this definition of a commercial facility differs little from the primary definition used in the RIA National Survey report.* The RIA National Survey's definition does set a threshold of at least 50 percent in defining "mostly" other firm wastes. Both the market analysis and the RIA National Survey definitions exclude commercial components to a noncommercial facility's business.

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*Section 5.3, p.83. A different definition is used in the report in Section 8.1, p.213.

- Noncommercial Facility. A noncommercial facility is either:

  - A publicly owned and operated hazardous waste management facility that, for a fee, handles mostly wastes received from other firms, or

  - A publicly or privately owned and operated hazardous waste management facility that handles mostly wastes received from the same firm, i.e., firms and/or facilities that are associated by ownership.

  In most cases in the report, the latter of these definitions tends to apply, and such facilities are referred to as on-site or captive facilities. This assumes that these facilities are located on or quite near the site where the wastes were generated, and that the firm generating the waste owns the facility. This usage, however, does not exclude the possibility that these captive facilities may receive same-firm wastes originating at some distance from them, or that they may have some business that could be classified as commercial.

- Liquid Organic Hazardous Waste (LOHW). These are a a group of wastes defined by the Office of Solid Waste as "any EPA hazardous waste that has been reported incinerated as a liquid or, according to the EPA Engineering Handbook For Hazardous Wste Incineration, is suitable for liquid injection incineration." These wastes are discussed in Appendix A. Reference to an "incinerable liquid waste" should be equated to LOHWs. An "incinerable liquid waste" may be either a liquid, solid, or sludge-type waste. A "waste" is defined by the context in which it is used, but usually this term has been used in reference to LOHWs.

- Quantity Incinerated Off-site or Quantity Incinerated At Off-site Facilities. These phrases are used interchangeably in the report in reference to the incineration of LOHWs at a commercial facility where these wastes were generated and shipped from off-site. The origin of these off-site wastes may be a firm that is or is not associated with the commercial facility by ownership.

- Off-site Wastes. These are wastes that have been generated mostly by other firms (i.e., firms not associated with the facility by ownership), and shipped from a location off-site to a commercial facility. The term off-site facility is considered to be a commercial facility handling mostly off-site wastes.

- On-site Wastes. These wastes that have been generated mostly by the same firm (i.e., a firm associated with a noncommercial facility by ownership), and sent to a noncommercial facility, whether or not that facility is located near the site of waste generation. The term on-site facility is considered to a noncommercial facility handling mostly on-site wastes.

APPENDIX F

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